First Aid

Diagnois and Management

FIFTH EDITION

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APPLETON-CENTURY-CROFTS, INC
NEW YORK

Library of Congress Card Number 60-5249

PRINTED IN THE UNITED STATES OF AMERICA

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Precautions and Limitations in First Aid Work General Principles of First Aid Common Conditions Requiring First Aid Material Needed Bandaging Wounds The Prostrate Patient Miscellaneous Conditions Frequently Requiring First Aid Care

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Preface

The first edition of *First Aid Diagnosis and Management* was prepared early in 1942 because our entrance into World War II produced an increased demand for knowledge of first aid It has long been recognized that civilian casualties far outnumber military casualties even in time of war, but the additional hazards of armed conflict make the public aware of the importance of first aid Careful planning and prophylactic measures have diminished the incidence of accidents in industry, but the frequency of other types of civilian injury, including automobile accidents, home accidents, and farm accidents is not decreasing, moreover, there is no indication that these accidents will be significantly decreased in the near future Disregarding the question as to whether there will be any more wars, the expectation that the incidence of civilian accidents will remain high makes it urgent that we continue to give serious thought to first aid, particularly since good first aid care often has a remarkably favorable influence on the ultimate results

It is now 18 years since the preparation of the first edition of this book During this time advancements in medical science have necessitated revisions of the text, which have been published in subsequent editions The great progress in science, industry transportation construction, and atomic energy and the increasing destructive power of implements of war as well as the great strides in our knowledge of medical care have convinced the authors that the entire text of First Aid should be thoroughly reviewed and largely rewritten This has been done A few factors dealing with well established fundamentals, basic medical principles, and tried and proven methods of treatment required little alteration The management of many emergencies previously described has been modernized, and the discussion of them has had extensive revision

Although the United States is not engaged in armed warfare at this time and it is our hope that this will not occur again, world conditions demand a constant alertness for such a potentiality Furthermore, civilian casualties and military casualties would not have the divergence of character and treatment that existed in World War II Warfare would involve the civilian population to a far greater extent than has any war of the past

Materials of war particularly those dealing with atomic energy, are becoming civilian tools and are thus diversifying their hazards Mass casualties were present in previous military conflicts but will be far greater in future wars and are potential hazards in times of peace It is, therefore, important to consider them in this text

One additional chapter Injuries of the Hand has been added We are most grateful to the former contributors for their cooperation All illustrations for First Aid Diagnosis and Management were made expressly for this text Where clarity or changes in concept required new illustrations these have been prepared

The authors wish to express appreciation for the most valuable assistance extended by Miss Josephine Magista Mrs Bess Walsh Sheehy and Mrs Ruth Scapino in the preparation of the manuscript We are indebted to Mr Gordon Blaha of the Department of Illustrations, headed by Mr Hooker Goodwin for the new illustrations We wish also to thank the publishers for their splendid cooperation and patience extended during the preparation of this material

WARREN H COLE
CHARLES B PUESTOW

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Precautions and Limitations in First Aid Work

WARREN H COLE

The type of first aid treatment indicated or required differs tremendously because of the great variety of accidents and conditions which may be encountered Although accidents of a certain type may diminish in frequency, accidents of other types will develop or increase, likewise there is no indication that emergency conditions of a nontraumatic nature will decrease Accordingly, the need for emergency care including the treatment of trauma will remain Emergency conditions usually require immediate attention and therapy, but only by accident are these patients seen first by the physician Often indeed effective first aid will save a patient's life which otherwise might be lost However, emergency conditions are so complicated and time for deliberation so short that first aid therapy is often carried out erroneously, even by physicians Accordingly, there will presumably always be a need for training in first aid, particularly since such a great variety of emergency conditions may be encountered

Errors in Judgment

On certain occasions, indications will be definite as to what is to be done, and no training or skill will be required, on other occasions, the indications will be so obscure or the type of treatment so complicated that even a well trained first aid worker will

reasonably sure of the indications before he performs some type of treatment which may be harmful if incorrect. It will usually be far wiser not to administer the treatment which is doubtful and possibly harmful, and to expend that energy in obtaining the services of one more highly trained or of a physician. The first aid attendant must, therefore, be certain that his proposed action is not foolhardy and damaging, rather than courageous and helpful as he had hoped and planned. This same philosophy must likewise be applied in the field of medicine. For example, a surgeon (perhaps well trained technically) must not be guilty of performing unwise and dangerous operations which will result in more harm than benefit on the assumption that he is being "courageous." Too often "courageous" treatment is in reality foolhardy and is based upon the fact that the would be Samaritan chooses to be spectacular and *does not put sufficient value on life*—the most valuable of our world possessions.

Necessity of Knowing Limitations of Ability

Since first aid work is often complicated, yet important, we wish to emphasize the necessity for accurate therapy, such therapy often requires medical training. In this volume we shall present many phases of first aid which are obviously *beyond the capabilities of one not possessing medical training*. However, we shall describe the complete first aid therapy for its educational value, so that the lay person may know the correct treatment even though often he cannot carry it out, at least this knowledge may prevent the lay person from carrying out erroneous therapy and inflicting damage to the patient. With few exceptions we state when this treatment is beyond capabilities of nonmedical personnel. The question as to limitations may be clarified to a great extent by the warning *that operations and anesthetics are not first aid procedures,* and are therefore outside the realm of

fail to administer proper therapy Removal of part of a wrecked automobile from the chest of a semiconscious individual is an example of the first condition, the erroneous utilization of a lot of time in the treatment of minor injuries while a serious condition such as shock remains untreated is an example of the second condition, thereby constituting a serious error in judgment The indiscriminate use of a tourniquet, of which first aid workers are so frequently guilty, likewise represents an error in judgment This precaution is particularly important because the need for a tourniquet in first aid work is in reality quite uncommon, since pressure dressings will control any hemorrhage except that from a large artery This point must be borne in mind constantly because *much harm can result from tourniquets*, the pressure of the tourniquet may *damage the tissue locally*, but of still more importance is the possibility of *development of gangrene if the tourniquet is left in place too long*

Errors in Technic

Just as serious as errors in judgment are errors in technic, such as application of bandages so tightly to badly injured tissue that its blood supply (already impaired) is obstructed completely, with consequent gangrene The application of bandages around a fracture without adequate splinting represents one of the most common errors made by the first aid worker The effort to stop bleeding with a tourniquet instead of a pack and pressure bandage is another common example of an error in technic

Erroneous Interpretation of Indications

First aid treatment may be lifesaving, but likewise may be seriously detrimental or *even fatal if injudiciously performed* For this reason the first aid attendant must be cautious and

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General Principles of First Aid, Common Conditions Requiring First Aid, Material Needed

WARREN H COLE

Although first aid procedures are numerous and extremely variable in type, first aid may be *defined* as the assistance rendered before definitive treatment can be carried out, it is usually performed at the scene of the accident Before medical aid is available, the responsibility for such treatment may rest upon nonmedical personnel

Although first aid is generally thought of as that assistance rendered injured persons it must be remembered that by no means all patients requiring first aid are the victims of injury, some will be stricken suddenly with an acute illness of a nonsurgical nature First aid in military life differs considerably from that in civilian life, just as the practice of medicine differs in the two situations For example, a very few instances of acute disease of the heart or uremia from severe kidney disease will be encountered in military life at least in a form requiring first aid treatment In civilian life proportionately many more patients with these diseases will be found helpless or unconscious (on the streets or elsewhere) and first aid will be necessary before a physician is available In war first aid procedures at the front lines will be limited almost exclusively to treatment of wounds and their results, gas attacks were common in World War I but were not used by either the Allies or the Axis powers in World War II or the Korean War

Many features of military first aid will be described in this book, particularly because during these Martian days, war may be brought to the doorstep of all by the merciless bombing of cities far from the battlefront even before war is declared Needless to say, many of the principles of first aid in civilian life are very similar to those employed in war The

first aid care We wish forcefully to remind the first aid worker of the old proverb which warns us so truthfully that "a *little* knowledge is a dangerous thing" The first aid worker must *know his own limitations in knowledge and ability, and abide by them*

and 4, *application of a tourniquet* If bleeding is mild, simple pressure over the wound will probably be sufficient to control it Naturally, one should not do this with the fingers or hand since such a procedure would contaminate the wound A freshly laundered and ironed handkerchief, towel, or sheet is reasonably sterile and in an emergency can be used for this purpose, if sterile surgical dressings are not available If the bleeding is profuse, simple pressure over the wound probably will not control it Pressure over the artery then will be indicated while a tourniquet is being found Numerous types of material, including rubber tubing belts and handkerchiefs, may be utilized for tourniquets Details of the care of the wound are discussed in Chapter 5, and control of hemorrhage in Chapter 7

The second important feature in first aid is to determine whether or not the patient is breathing and the heart is beating In reality, this is just as important as hemorrhage With few exceptions, the function of respiration will be present as long as the heart is acting sufficiently to produce a hemorrhage *Circumstances of the emergency will often determine what type of aid should be applied first* For example, if the patient is unconscious and has just been retrieved from the water attention must be directed immediately to respiration If the patient is bleeding from a wound and respirations have also ceased the bleeding may be controlled in 10 or 15 seconds by a pack and artificial respiration begun Such a combination of circumstances will be rare More common will be *cardiac arrest* and cessation of respiration often developing spontaneously without accident Although nonmedical personnel may carry out artificial respiration medical assistance will be necessary to treat the cardiac arrest (see Chapter 14) Respiration may be detected in numerous ways for example by watching and palpating the chest and abdomen for respiratory excursions and by watching the alae of the nose for movements The age old method of detecting life by holding a mirror in front of the nose or mouth is neither practical nor accurate Another effective method of detecting expired air is to hold one s face or hand close to the patient s nose or mouth The skin of the face is more sensitive than that of the hand and will perhaps detect more readily the air current set up by exhalation However this method is not as effective as the two just mentioned If there is indication that breathing has just ceased, artificial respiration usually will be indicated until one is convinced that the patient is dead Artificial respiration as will be discussed in detail in Chapter 13, must be conducted for a period as long as thirty minutes or so before giv

prominent differences between the two types of injuries are discussed in Chapter 25

Conduct of First Aid Personnel When an accident is encountered, one of the first things to consider and ascertain is whether or not anyone is conducting first aid If not, it will presumably be up to you to volunteer your services and perhaps take charge of the first aid work—at least until more competent assistance arrives You should first find out whether or not a physician has been called If not ask an observer to do so In such emergencies you must remain calm and conduct yourself in a tactful manner You should act quickly but not with too much haste, and speak in a natural voice An air of commanding efficiency inspires confidence in the patient and bystanders You should silence exciting remarks of spectators and reassure the patient if he is perturbed The crowd should be dispersed from the injured person primarily to give him air If it is warm it may be advisable to have one or two spectators fan the patient while you are conducting your examination and first aid This will keep some of the spectators occupied and at the same time will have a beneficial effect upon the patient

Observation of Surroundings One should make a quick survey of the conditions related to the injury or accident Accurate observations may lead to discovery of the type of injury The position of the body may determine the mechanism and type of injury A few glances about the scene of the accident should determine whether or not any weapons are present—thereby obtaining information as to a possible suicide or homicide If the patient has been injured and it appears that the injury was inflicted intentionally by the patient or other persons, the police should be called Inquiry should be made of the spectators as to whether or not anyone knows the patient When identification is obtainable, relatives should be notified The data obtained from observers, as mentioned will require only a few seconds in its accumulation Naturally, precious time should not be wasted on such data when the patient may be in need of immediate attention Much of this information may be obtained while the first aid volunteer is working on the patient

Immediate Aid to the Patient The most important issue from the standpoint of aid to the patient is to *determine whether or not the patient is bleeding* If hemorrhage is present it must be stopped immediately since the loss of blood from a large artery may be sufficient to produce death in less than a minute if uncontrolled Hemorrhage can be stopped by one of four methods 1 *pressure over the wound* with a dressing 2 *digital pressure in the wound* 3 *pressure over the artery above the wound*

necessary, liquids by mouth will *complicate the anesthesia* by encouraging vomiting, and perhaps result in aspiration of vomitus into the bronchial tree of the lungs—a complication which is serious because of the danger of pneumonia

Examination of Patient During the process of performing the necessary first aid treatment you will, no doubt, have examined the portions of the body obviously injured After immediate aid has been rendered, a complete physical examination will be indicated, particularly if the physician has not arrived Naturally, the history leading up to the patient s illness or accident will be extremely important and may lead to the exact diagnosis or discovery of additional injuries For example, if the patient fell more than a few feet and landed on his feet fractures of the bones in the feet and ankles would be likely, even though the chief complaint might be pain in the shoulder Furthermore, if the injured person landed on the buttocks, fractures of the vertebrae or base of the skull might be sustained

In order to make the examination complete and not omit some part of the body, a systematic examination should be made Before carrying out the examination a thorough inspection should be made The examiner has already determined whether or not the patient is conscious and has likewise probably palpated the radial or temporal pulse The skin should be inspected as to color, i e , cyanotic (bluish color) or flushed One should determine whether or not the patient is sweating profusely and if his respirations are abnormal

In his *examination* the examiner should start at the head Palpation is carried out particularly over the scalp, to detect bruises, bony irregularities or asymmetry The ears are examined, particularly for the presence of blood this is important as will be discussed in detail later because bleeding from the ears so often is indicative of a fracture of the base of the skull Bleeding from the nose is not so serious and may indicate nothing more than a buckling of the cartilage in the nose The mouth particularly should be examined for the presence of foreign bodies including broken teeth or loose dentures It is very essential that foreign bodies of any type be removed since the unconscious or half conscious patient is so apt to aspirate these foreign bodies Examination of the mouth is also indicated for the possible presence of burns which might be inflicted by poisons

The examiner should smell the patient s breath carefully since certain odors may lead to the diagnosis For example an acetone breath may be indicative of a diabetic coma, and an alcoholic breath may be indicative

ing the patient up as dead Naturally, the type of wound or injury may make it apparent that the patient is dead

Any acute distortion of the body should be corrected, but care must be utilized in doing so lest a fracture be present and damage done by the manipulation Determine whether or not the patient is unconscious by talking to him and asking him questions If he is unconscious and vomiting, turn his head to the side to prevent aspiration of stomach contents *Aspiration of stomach contents* can readily occur in patients who are only partially conscious, and *is extremely serious* because of the danger of suffocation and of the development of aspiration pneumonia later *Do not let the patient* see his own injuries Place him in a comfortable position with his head slightly elevated if he is not unconscious If he is unconscious, place his head level with his body If he is in shock it is essential that his head be lower than his body, as will be discussed later *Under no circumstances have him sit up or stand* until it is ascertained that his injury or illness is trivial

Free the mouth of any foreign substance which may obstruct breathing Loosen tight clothing such as collar, vest belt, etc The various phases of respiratory obstruction will be discussed in detail later, but the subject is mentioned here because it represents one of the first points to investigate

Naturally, it may be necessary to remove clothing to examine the patient or treat his injuries If it is necessary to obtain access to a wound *immediately* the clothes should be cut or ripped If there is no hurry about exposing the injured part the clothing may be removed in a normal way, removing the clothes from the uninjured part first

If the patient is cold (particularly if the temperature is below "room temperature) apply warmth If bystanders are present they may be asked to obtain hot blankets or a hot water bottle To obtain the proper warming effects of blankets they must be placed *under the patient as well as over him* The blanket under the patient serves also to make him comfortable

Do not be in a hurry to move the patient If he has a fracture it will be preferable to let him remain lying down where found until a splint is obtained to immobilize the fracture One should endeavor to make the patient comfortable until some sort of equipment for splinting is obtained

Be very slow to give the patient stimulants by mouth Alcoholic beverages are in general contraindicated Hot coffee or tea are satisfactory but *no liquids or food of any kind should be given until* it is ascertained that an operation will not be necessary If an operation is

take place inside body cavities—for example, peritoneal cavity, thoracic cavity, and cranium. It should be remembered that crushing injuries may not break the skin but may be sufficiently serious to produce death with a relatively small amount of associated hemorrhage. Naturally, the site of the crushing injury will determine its severity, since certain areas including brain and cardiac (heart) muscle, do not tolerate crushing without endangering life.

Absence of breathing is, of course, associated with cessation of life, but it should be emphasized that on numerous occasions the heart is still beating and life can be saved with proper therapy performed immediately. Numerous conditions, including electrical shock, foreign body in the larynx or bronchi (air passages to lungs), drowning, aspiration of vomitus, and carbon monoxide poisoning, may result in cessation of breathing, as will be discussed later. *An increase in respiratory rate* may be produced by numerous conditions, the most common in emergency conditions being fright and exhaustion. Heart disease may produce an increase in the rate. Obstruction of the respiratory passages may increase the respiratory rate, but there usually will be an accompanying audible stridor indicative of obstruction. *Irregular breathing* (a common type of which is known as Cheyne Stokes respiration) is encountered in numerous emergency conditions. Uremia (due to kidney disease), injury of the brain, and spontaneous rupture of a blood vessel in the brain (commonly known as apoplexy or a stroke) may produce this irregular type of respiration.

Unconsciousness is a serious manifestation and may be defined as insensibility to all stimuli. The patient is not capable of motor function, that is, of body motions. There are, of course, all degrees of unconsciousness, from complete lack of motor function and sensory perception to merely a slight mental confusion. The term "mental confusion" or "delirium" is more accurately applied to patients with the latter type of disturbance. Perhaps the most common cause of unconsciousness is head injury. It also may be encountered in uncontrolled diabetes, apoplectic strokes, rupture of vessels in brain tumor, alcoholism, poisoning, etc. The term "coma" is frequently applied to patients who are unconscious because of physiochemical reasons, for example, diabetic coma and uremic coma (seen in late stages of kidney disease).

Paralysis is a serious manifestation and perhaps is most commonly observed in apoplexy, i.e., rupture of a blood vessel in the brain. In this condition the paralysis usually is limited to one side, including perhaps the arm and the leg. Such a type of paralysis likewise may be found when

of inebriation. However, we cannot emphasize too strongly that the presence of *alcohol on the breath is not proof* that the patient's half conscious or unconscious state is due to alcohol. It is a very serious error to attribute a comatose or unconscious state to alcohol when the real cause of unconsciousness is intracranial (brain) injury. The back of the neck should be palpated very gently for the possible presence of bony deformities.

The examiner palpates the clavicles (collar bones) and shoulders for tenderness, bony irregularities or asymmetry. The chest and abdomen are examined for bruises and tenderness, as will be discussed in detail in a subsequent chapter. One of the most significant features about the abdominal examination is to determine whether or not muscle spasm is present. Muscle spasm is highly suggestive of serious intra-abdominal injury.

It is particularly important that the back be examined for the possible presence of fractured vertebrae, especially since such injury is so serious and so commonly overlooked, even by competent physicians. Undue tenderness or malalignment of the spinous processes in the midline of the back may be indicative of fracture. As will be discussed later, *patients with fractured vertebrae should be moved with extreme caution* lest serious damage be inflicted upon the spinal cord.

Each extremity is palpated gently for tenderness and bony irregularities. Carefully rotate all extremities, as movement of joints will detect significant injuries. Frequently it will be impossible to determine by history and examination alone whether or not a fracture is present. On such occasions an x ray should be taken later *by the physician*— in fact *an x-ray should be taken of all bones which might possibly be the site of a fracture.*

Common Symptoms and Signs Encountered. Symptoms and signs which may be referred to as clinical manifestations, constitute the important factors leading to diagnosis. In general, it is necessary to have a correct diagnosis before intelligent and effective therapy can be instituted. However, many conditions are found and interpreted correctly in a general way without the first aid attendant being aware of the etiologic factors involved.

One of the most alarming and serious manifestations presented by the patient is *hemorrhage*. If the hemorrhage takes place at the site of an open wound, it will readily be detected. In general, the severity of the effects of hemorrhage is proportionate to the amount of blood lost, as will be discussed later. Hemorrhage may take place under the skin. When it occurs locally in the soft tissues it will be detected as a swelling commonly associated only with a slight degree of tenderness. Hemorrhage may also

Examination for *abnormality in the radial or temporal pulse* will give a fairly accurate and quick estimation as to the immediate state of the circulatory system, reflecting in general the heart action. Naturally, the pulse will be absent if the patient is dead. It may also be absent in shock of various types. In general, therapy must be immediate and efficient to save life if shock is so pronounced as to produce an absent pulse. These features are discussed in detail later. Acute heart attacks may produce various types of abnormalities in the pulse, including absence, weakness, tachycardia (increased rate), and irregularity. Irregularity of the heart rate is not often produced by injury except when the injury has resulted in hemorrhage into the pericardial sac surrounding the heart. This condition of increased pressure in the pericardial sac is known as cardiac tamponade. It must be remembered that simple conditions such as fright and exertion may produce an increase in the heart rate. A decrease in the heart rate, below normal, will be encountered in relatively few conditions in first aid work. Perhaps the most common condition would be injury to the brain resulting in increased pressure within the cranial cavity.

Convulsions may be due to a number of causes—most of which will not be related to injury. However, most any type of brain injury can produce convulsions. Certain types of poisons, such as strychnine, will produce convulsions. Children particularly are prone to have convulsions, and sometimes with slight provocation, often high fever in itself will cause convulsions in children. Convulsions are common during attacks of epilepsy, during which the patient usually loses consciousness, froths at the mouth, and frequently bites his tongue.

The presence of *fever* usually indicates that the patient's difficulty is not due to accident. Very few accidents, including brain injuries, can produce fever in a short time. In general, the presence of fever indicates some sort of infection. The patient may have been suffering from a serious acute illness producing fever and such severe weakness as to cause him to collapse upon exertion. If the patient is conscious he can give you the history of his illness preceding his collapse. In hot weather, high fever may be encountered in sunstroke.

COMMON CONDITIONS REQUIRING FIRST AID

The accidents or illnesses which may require first aid are numerous. Frequently there will be difficulty in arriving at the correct diagnosis. In order to give the student a preliminary idea as to the scope of first aid

a hemorrhage has occurred within a brain tumor, and in brain injuries If the paralysis includes both sides, i e , both extremities, most likely the explanation would be injury to the spinal cord The height of the paralysis will vary depending upon the site of injury Further details of spinal cord and brain injuries will be discussed later

Any change in the *color and condition of the skin* should be noted A cold, clammy skin is encountered in shock of all types, including true surgical shock due to injury, and psychic shock as well Fainting might be classified as a type of mental or psychic shock Pain itself may produce a cold, clammy skin and other manifestations of shock Bluish discoloration (cyanosis) is perhaps most frequently encountered in acute heart disease Cyanosis also may be produced by poisons, obstruction to respiration, etc Flushing or cyanosis of the skin may be noted in certain types of gas poisoning It should be remembered, however, that exertion excitement, fevers and alcoholic intoxication may produce flushing

Much information can be gained from the *appearance of the pupils* Marked bilateral dilatation accompanies death, but it may be encountered in atropine or belladonna poisoning Contraction of the pupils is suggestive of opium or morphine poisoning Inequality may be encountered in brain lesions

Hemoptysis or coughing of blood would suggest one of two major conditions 1, injury to the lung or 2 pulmonary hemorrhage due to tuberculosis cancer or some other disease process The history of an accident would, of course differentiate these two conditions The most common cause of hemoptysis caused by injury would be puncture of the lung by a fractured rib Contusion of the lung or the air passages could likewise produce it At times injury to the mouth or nasal cavity producing hemorrhage may cause the patient to cough, bringing up aspirated blood thus simulating hemoptysis

Vomiting may be encountered in numerous conditions Shock of any type might induce it, particularly if the patient has eaten a hearty meal shortly preceding the accident Children are particularly prone to vomit with slight provocation Chemical poisoning and acute food poisoning (usually due to bacteria) also may produce vomiting Vomiting of blood usually is indicative of a hemorrhage in the stomach or duodenum but it should be remembered that blood arising from the mouth or nasal cavity may be swallowed and later vomited True hematemesis that is vomiting of blood usually is encountered in acute injury affecting the upper intestinal tract or a bleeding peptic ulcer

MATERIAL REQUIREMENTS FOR A FIRST AID KIT OR STATION

2 ounces of 2 per cent aqueous solution of iodine (U S P)
2 ounces of soft soap (U S P)
6 ounces alcohol (60 per cent)
6 sterile cotton pads (*covered with gauze*)
1 cotton roll 3 inch
24 sterile square gauze compresses
1 roll 3 inch adhesive plaster
6 yards muslin 5 inches wide
4 gauze bandages of each size 1 2 and 3 inches wide
2 cloth slings 1 yard square
2 tourniquets (rubber tubing or equivalent)
2 dozen bichloride of mercury tablets U S P (use 1 to 1 pint)
1 Thomas or half ring splint for leg
1 Thomas arm splint
3 pairs hemostats (artery forceps)
1 bandage scissors
2 dozen safety pins
2 ampules antivenin
4 ampules tetanus antitoxin serum (1 500 units each)
2 morphine tablets grain ¼ (or 2 syrettes of morphine)
1 hypodermic syringe with needle
2 ampules procaine crystals 0 5 gm (for an 0 5 per cent solution)
1 scalpel with blade
1 pair surgical scissors
2 surgeon s cutting needles No 5
2 small straight or curved cutting needles
1 mouse tooth forceps
1 small needle holder
2 tubes 4 0 silk
2 tubes 2 0 silk
2 tubes 5 0 nylon
1 tube #1 chromic catgut
1 tube 3 0 chromic catgut
6 ampules penicillin (300 000 units each)
1 bulb syringe—large
1 gastric lavage set—Ewald tube bulb basin
16 ounces 1/10 000 potassium permanganate solution
2 universal hand splints
3 aluminum splints 18 x 4 inches

work, some of the important conditions requiring first aid will be mentioned now, but details will be presented later

These conditions can be separated into two broad groups 1, civilian, and 2, military emergencies Some of the details of military emergencies are discussed in Chapters 5 and 25, but a few will be presented here so that certain principles can be emphasized Many in the two groups will be identical Open wounds will be the primary emergency encountered in military first aid but will constitute only a portion of civilian emergencies *Hemorrhage* and *shock* may be encountered in either group Manifestation and treatment will differ only slightly in the two groups except that more plasma than blood will be used for therapy in military than in civilian shock *Blast shock* of war rarely will be observed in civilian life *Fractures* will be very common in either group Compound fractures will be more common in war because of the force producing them—that is, bullets, shrapnel, etc *Automobile accidents* are a frequent cause of injury in civilian life and may result in almost any type of injury *Fracture of the skull with intracranial injury* will be common in civil or military life but in war the fracture of the skull is more apt to be compounded because of bullets shrapnel and flying debris *Bullet wounds* involving any portions of the body will be encountered in either group In World War I, by far the majority of wounds were due to bullets or shrapnel, but in World War II the incidence of such wounds was smaller except on the Russo-German front Except on this front *blast injuries* and burns constituted the majority of wounds in that war Blast injury may be trivial or fatal, strange to say it may be fatal without any evidence of an external wound *Burns* are common in either group and in general are serious They may be caused by numerous agents—usually fire explosives or inflammable solutions *Respiratory emergencies* are relatively uncommon and are seen most frequently in near-drowning Children are apt to aspirate foreign bodies some of which lodge in the larynx requiring immediate removal or tracheotomy In war massive wounds involving the mouth and neck may block the respiratory passage with blood or torn tissue War wounds of the chest may leave large defects in the thoracic wall, and the consequent pneumothorax may be rapidly fatal unless immediate aid is available to close the defect with some type of dressing or by operation Numerous *medical emergencies* are encountered in civilian life, but few in war Of this group, *fainting* is the most common Acute *heart failure* is also common and unfortunately associated with a high mortality rate *Poisoning* due to ingested chemicals or to inhaled gas is relatively common and serious

sent a safe antiseptic for wound application, because of the poisonous element mercury contained in them Their germicidal quality is likewise decreased markedly in the presence of proteins

MISCELLANEOUS ANTISEPTICS Many *dyes* are effective antiseptics Of this group acriflavine, proflavine sulfate and proflavine monohydrochloride are worthy of mention *Zephiran Chloride* in 1 to 1,000 solution is a very effective antiseptic By adding an antirust compound it can be used effectively for cold sterilization of knives and scissors

Chemotherapy During recent years it has been shown that chemical substances isolated from certain fungi and yeasts have a very strong bacteriostatic and bactericidal quality Penicillin streptomycin, Aureomycin, Chloromycetin, tetracycline, erythromycin, and Terramycin are the antibiotic agents most commonly used They are much more effective than the sulfonamides Although these agents will not be used by the first aid worker a brief discussion of their use and value is presented here because of their great importance in the definitive care of open wounds

Penicillin was the first of these drugs to be discovered It is derived from a mold and was discovered by Alexander Fleming of London in 1929 Not much was done clinically with the substance until 1940 when Florey and his associates began clinical studies with it Since that time it has been used universally The toxicity of the drug is found to be minimal Ordinarily, 200,000 to 800,000 units are given in a 24-hour period, although in serious infections this dose may be doubled or tripled particularly during the first 24 hour period Penicillin is not very effective when given by mouth and thus is usually given intravenously or intramuscularly It is not absorbed well when given subcutaneously It has been found to be effective against practically all gram positive coccus organisms including staphylococcus, streptococcus and pneumococcus It is likewise effective against gas gangrene actinomycosis and even the primary and secondary lesions of syphilis It is slightly effective against most of the gram negative bacteria Examples of diseases produced by these organisms are typhoid and dysentery It has been used in tuberculosis acute rheumatic fever ulcerative colitis and malaria but found not to be effective in these diseases Penicillin can be used *locally* but the powder itself is irritating to the wound surfaces, it is therefore, used only in solution The concentration should be no greater than 250 to 500 units per ml It can be used as an irrigating solution or can be poured on the dressings at intervals of 4 to 6 hours as indicated The most significant disadvantage of penicillin is the fact that certain bacteria, particularly the staphylococcus become resistant to it

ANTISEPTICS AND CHEMOTHERAPY

Antiseptics Although numerous effective antiseptics are available, there is no substitute for the cleanliness afforded by soap and water Practically all antiseptics are irritating to raw tissue, consequently they are not advised for routine use in deep wounds, even minor ones If the wound is shallow, i e of the abrasion type the entire area including 2 or 3 inches of surrounding skin may be cleansed with soap (bland) and water A mild antiseptic may be applied over superficial wounds of this type

IODINE All investigators have found iodine (2 5 per cent tincture or U S P Compound Solution of Iodine) to be a very effective antiseptic However, it has recently been appreciated that iodine in almost any of its forms *is very irritating and deleterious to tissue cells* For that reason it *must not be* poured into a deep wound Tincture of iodine even in the weak solution (2 5 per cent) tends to blister the skin of many people This is another disadvantage although removal of the iodine with alcohol after 20 to 60 seconds lessens the irritation to the skin

ALCOHOL Ethyl alcohol is widely used for surface application but in reality is a very weak antiseptic It is most effective in a 50 per cent solution Its application to an open wound creates considerable burning and pain it likewise is damaging to the tissue cells of an open wound It is therefore an unsatisfactory substance for first aid work

MERCURY COMPOUNDS Heavy metals have been used as antiseptics for many decades of the group, compounds of mercury are the most effective The *inorganic salt* bichloride of mercury is very effective even in weak solutions It is commonly used in a strength of 1 to 1 000 However it is so poisonous that it dare not be used in or near open wounds Moreover in the presence of proteins the drug loses its germicidal quality Because of these disadvantages the drug is not useful in first aid work it is of course a very effective antiseptic for hospital use Numerous compounds containing bichloride of mercury have been utilized Novak s solution which contains 0 07 per cent mercuric chloride and 0 5 per cent tricresol in alcohol and acetone (Surgery 5 560 1939), is very useful as a skin antiseptic preparatory to operations but cannot be used in a wound Numerous *organic compounds* of mercury have been made particularly by pharmaceutical companies Merthiolate, Metaphen and Mercresin (all of which are effective in 1 to 1 000 solution) are a few of the ones which have been found satisfactory for certain purposes, but do not repre-

3

Anatomy and Physiology

CHARLES B PUESTOW

For one to administer first aid intelligently he should have some knowledge of the structure of the human body and the functions of its component parts Our body is a complicated mechanism, so constructed that it can exist develop, and reproduce itself and also can mend its own injuries, and combat enemy forces such as disease and often partial destruction The chief value of most first aid care as well as the bulk of medical therapy is to render conditions most favorable for the body to recover from various types of diseases or injury It is not our intention to present in detail human anatomy and physiology, but merely to review briefly those essentials which are important for the administration of sound first aid

Anatomy is the study of the structure of the component parts of the body and their relationship to each other *Physiology* deals with the activity or functions of these various parts As a machine is built of various types of material so arranged and integrated as to perform as a single unit, so the living body is composed of various types of tissues each supporting and aiding the others The smallest unit of the body is the *cell* of which there are many types A group of similar cells connected together and serving a definite purpose is spoken of as a *tissue* A number of tissues which are grouped together and perform a definite function constitute an *organ* as for example the heart A group of organs which act together to perform a main function of the body is spoken of as a *system* The main systems of the body are the skeletal muscular, nervous, respiratory, circulatory, digestive, excretory endocrine, and reproductive

STRUCTURAL SYSTEMS

Because the functions of the skeletal and muscular systems are so closely related, and injury to one so frequently involves the other, it is well to consider them together The *skeleton* (see Fig 1) consists of many

Streptomycin is particularly effective against gram-negative bacteria It may be given orally or intramuscularly in doses of 1 to 2 grams per day If given in larger doses there is danger of damage to the eighth cranial nerve

Aureomycin is effective against a great variety of bacteria, it is often more effective than penicillin because fewer bacteria are resistant to it It is useful in many rickettsial and viral diseases The oral dose is 3 grams per day in divided doses for an adult, the intravenous dose should be no more than one fifth that amount

Chloromycetin is quite effective against the *E coli* and *S typhosa* organism as well as many rickettsial and viral diseases, it is very useful in infections of the urinary tract The dose is 3 to 5 grams (orally) per day in divided doses

Tetracycline is an extremely effective drug against a wide variety of organisms but certain bacteria (especially the staphylococcus) tend to become resistant to it

Erythromycin is effective against a wide variety of bacteria It is particularly useful because very few bacteria become resistant to it

bones joined together by ligaments, and hinged in many places to permit motion The functions of bones are to give form to the body, rigidity and strength to certain parts, and protection to many vital organs In order to permit locomotion of the entire body as well as motion of one part upon another, many bones are connected by *joints* A joint may permit movement and yet must have stability As a general rule, the greater the range of motion of a joint, the less stable and more easily injured it will be For example the shoulder joint offers a great degree of motion but is easily dislocated The elbow joint, in contrast, allows motion in one direction only, and that to a limited extent It is so stable, however, that injury will more frequently break the bones than dislocate them at the joint Where both stability and motion in various directions are needed as in the wrists and ankles, we are provided with many small bones with joints between each

The movement of one bone upon another is accomplished by the action of *skeletal muscles* To produce motion in a joint a muscle must be attached to the bones on each side of it To help support the joint and to produce motion in opposite directions opposing muscles are present one relaxing when the other contracts Where the bulk of a muscle would interfere with the use of a part of the body, the main muscle body may be located at some distance and is connected to the bones by *tendons* This is true in the hands and fingers, most of whose movements are produced by muscles in the forearm There are no muscles in the fingers but tendons from muscles located in the hand and forearm control their motion

There are three types of muscle 1 *skeletal muscle* which produces all voluntary motion and is under control of the will, 2, *smooth muscle* found chiefly in the walls of the stomach intestines, blood vessels, and various ducts and organs in the body and not under voluntary control and 3, *heart muscle* which likewise functions involuntarily The action of a muscle is initiated by a stimulation transmitted from the central nervous system through nerves

Extremities Although our arms and legs are not vital structures and we can live with the loss of one or more they are extremely important to our comfort independence and earning ability A severe injury to a hand may not jeopardize one s life as much as a body injury but it may be far more crippling and may cause much permanent unhappiness For this reason injuries to the extremities demand the greatest care

The *upper extremity* consists of the shoulder arm forearm wrist hand and fingers Two bones are present in the shoulder 1 *the clavicle* (collar bone) and 2 the *scapula* (shoulder blade) The clavicle is at-

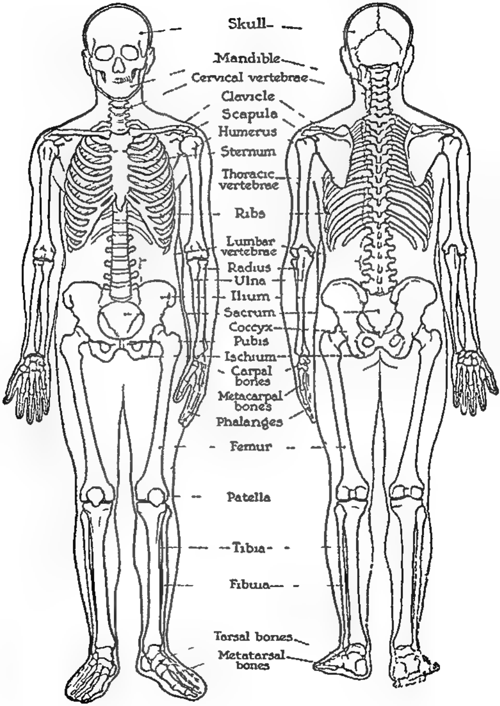

Fig 1 Anterior and posterior views of skeleton

back of the wrist close to the surface Lacerations here may sever these tendons and thus cripple the fingers Nerves are located close to the surface here and also may be severed There are five *metacarpal* bones in the hand, each joining with the carpal bones at the wrist and the finger bones *(phalanges)* at the base of the fingers and thumb The thumb has two phalanges whereas each of the other fingers has three Too much emphasis cannot be placed upon the importance of the hands The great majority of people are entirely dependent upon them for their livelihood The loss of a hand may convert one from a self-supporting individual to a disabled, dependent, and unhappy invalid The thumb is the most important digit A good thumb and any one finger gives a very useful hand Four fingers without a thumb is of much less value

The *lower extremity* consists of the hip, thigh, knee, leg ankle, foot, and toes Because of its important weight bearing function, the lower extremity has greater stability than the upper, but has a smaller range of motion in most joints

The hip forms the junction between the lower limb and the body It contains the *innominate* bone formed by the union of three bones the *ilium ischium* and *pubis* It joins with the spine posteriorly and with the other innominate bone anteriorly to form the bony pelvis These joints are very solid and allow practically no motion Joint strength is very important here, more so in man than in other animals because in walking in the erect position the entire weight of the body is thrown upon these joints Thus, in spite of their strength the joints between the innominate bones and the spine (sacro iliac joints) are often subjected to very great strain and may be injured This is one of the common causes of low back pain Within the bony pelvis, which is a funnel-shaped cavity, lie several important structures including the bladder and rectum Crushing injuries to the pelvis may cause the bone to be fractured and broken fragments may injure or tear the viscera within the pelvis

On the lateral surface of the innominate bone is a cup-shaped cavity into which the rounded head of the thigh bone (femur) rests to form the hip joint Although this is a ball and socket joint it is quite stable in comparison to the shoulder joint and requires much more force to be dislocated With its increased stability it permits a smaller range of motion Because a great deal of strength is necessary to support and move the body when we are standing walking or running powerful muscles are necessary to control the motion of the thigh and leg especially those motions in which the hip joint is involved To supply this power large muscles exist in the hip and in the thigh

tached at one end to the sternum (breast bone), at the other end near the tip of the shoulder it joins with the scapula The scapula has no other bony attachment to the body, being fastened to the back of the chest by muscles and, therefore, has a wide range of motion It is triangular in shape with its upper edge comparatively horizontal The lateral corner spreads out to form the acromion process (tip of shoulder) to which muscles are attached and which overhangs the shoulder joint Because the collar bone is long and thin, is attached at both ends, and is close to the surface, it frequently is broken As the scapula is firmly fixed at only one corner and as it is fairly well protected by muscle, it rarely is fractured The nerves and vessels of the shoulder are well protected by bone and seldom are injured The arm possesses only one bone the *humerus*, one end of which is rounded and fits into the shoulder socket, the other end joining with the bones of the forearm to form the elbow joint The shoulder joint permits a great range of motion and is quite weak It is therefore, frequently dislocated The large amount of muscle tissue around the joint gives some added support to the joint capsule and ligaments The shaft of the humerus is surrounded by muscles which protect the bone as well as the vessels and nerves which are located close to the bone However, a bad fracture of the humerus may cause considerable muscle damage and also may injure the artery or nerve The elbow joint is formed by the junction of the humerus and ulna, and is a strong hinge joint which permits motion in one direction only and that limited to 135 degrees Most vessels and nerves pass anterior to the bones at the elbow where they are most protected The ulnar nerve passes behind the medial part of the elbow and is easily bruised causing pain down the inner side of the arm (crazy bone)

The forearm possesses two parallel bones the *radius* and *ulna* The ulna is on the medial side, is large at the elbow and small at the wrist The radius lies on the thumb side, is small at the elbow and large at the wrist Many of the arteries and nerves passing through the forearm lie between and are partially protected by these bones Joint action of these bones on each other permits rotation of the forearm (pronation and supination), a very important motion The distal end of the radius spreads out to form a broad surface to articulate with the bones of the wrist When a person falls on his hand the impact is transmitted to the distal end of the radius often fracturing it (Colles fracture) In the wrist are eight small bones (*carpal bones*) arranged in two rows of four each They articulate with one another as well as with the bones of the forearm and hand and permit a wide range of motion Many of the tendons extending from muscles in the forearm to bones of the hands and fingers pass down the front and

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The *femur*, the only bone in the thigh, is the longest bone in the body Although it is very strong, it is not infrequently broken because of the great stress which at times may be put upon it In elderly persons whose bones have become more brittle, fractures at the upper end (neck) frequently result from falls and other comparatively simple injuries Fractures of the femur are serious accidents because of several anatomic and physiologic characteristics The large amount of muscle around the bone makes it difficult to bring the fractured ends together and maintain them in good position The great force necessary to break the bone often is transmitted through the jagged end into the surrounding muscles causing extensive muscle damage Enough bleeding from such injuries can occur into the muscles and the surrounding soft tissues to produce severe shock, which may be fatal

Many essential motions are present in the hip joint and are controlled by opposing groups of muscles Thus one group of muscles swings the thigh forward (flexion), another posterior group swings it backward (extension) one group pulls it laterally (abduction) and another pulls it toward the midline (adduction) Still others permit rotation of the thigh to some degree These are complicated and coordinated motions which are essential to normal locomotion The lower end of the femur broadens out to form two rounded knobs, the medial and lateral condyles These articulate with and rest upon the upper surface of the tibia to form the knee joint

The knee joint is a very strong hinged joint which allows limited motion in one plane only but which is strongly supported by ligaments The joint is protected in front by a small disc shaped bone, the *patella* (knee cap) This bone is embedded in the tendon of the powerful anterior group of muscles (quadriceps) which extends down the thigh and by means of a tendon is fastened to (inserted) the upper anterior surface of the tibia As the knee cap receives the force of falls upon the knee it frequently is injured and often fractured If fracture is complete and the surrounding tendon divided the fragments will separate and the patient will be unable to walk Besides this protective function the knee cap gives greater leverage to the muscle action which straightens the leg upon the thigh (extension) Most of the large vessels and nerves which extend down the thigh continue behind the knee joint where they are least likely to be injured

The portion of the lower extremity extending from the knee to the ankle is called the leg It contains two bones the larger, which supports the weight of the body and is on the medial side is the *tibia* The *fibula*

lies lateral to the tibia and although it helps form the ankle joint at its lower end, it is not a weight bearing bone The upper surface of the tibia is broad and flattened, and articulates with the condyles of the femur The shaft of the bone is somewhat triangular in shape with an edge extending down the anterior surface (shin) Its lower end has a flat surface which articulates with the ankle bone (*talus*) and has a bony prominence extending down the medial side (the internal malleolus) which supports the ankle on this side The upper end of the fibula extends to the knee joint but does not form a part of it The lower end extends down lateral to the talus and supports and protects the lateral portion of the ankle joint The most powerful muscles of the leg are on the posterior portion and form the calf of the leg The blood vessels and nerves lie largely between the two bones and are protected by them

The ankle contains seven *tarsal* bones, which are larger than the corresponding eight carpal bones of the wrist They also have greater support and less mobility They permit a fairly wide range of motion but are sufficiently strong to support the weight of the body With the bones of the foot they form the arches which are very important in normal walking In the foot are five *metatarsal* bones, which correspond to the metacarpal bones of the hand One end of each of these bones articulates with bones of the ankle and the adjacent metatarsal bones The other end articulates with the first phalanx of the corresponding toe The first toe has two bones or phalanges corresponding to the thumb, the other toes have three Motion of the ankle, foot and toes is produced largely by the action of muscles located in the leg These muscles are connected with the respective bones by tendons

Head The bony portions of the head (skull) can be divided into two main divisions 1 the cranium which is the cavity containing the brain and 2 the bones which make up the face The cranium is composed of eight bones and the face of fourteen The bones of the cranium are so constructed that they have great strength in proportion to their weight This is accomplished partially by their composition of an outer and inner firm table of bone between which there is a spongelike bony framework This may be compared in principle to that of structural steel or corrugated paper The rounded shape also gives added strength by transmitting the force of a blow received in any one area to the entire cranium Although eight separate bones make up the cranium they are so firmly united by irregular edges set together like jigsaw puzzles that no motion is permitted between them The large bone in front underlying the forehead is called the *frontal* bone The *occipital* bone forms the back and base

of the head and on each side are the *parietal* bones Below these are the *temporal* bones which contain the ear canals Between the cranial cavity and the bones of the face are two other bones, the *sphenoid* and *ethmoid* The occipital bone articulates with the uppermost bone of the spine and has a large opening in it through which the spinal cord passes

A number of small openings in the floor and anterior portion of the cranium permit the passage of blood vessels and nerves, especially those dealing with our special senses and those controlling muscles of certain head organs such as the eyes and tongue The brain and its coverings fill the cranial cavity except for a small amount of fluid which covers the brain and helps both to nourish it and to act as a protective cushion when the head is injured Soft tissues of the body tend to swell when they are injured Swelling of the brain likewise occurs when it is injured However as the size of the cranial cavity cannot enlarge to accommodate this swelling increased pressure on the brain develops and may produce headaches, vomiting, disturbed vision and mental confusion or unconsciousness (symptoms of concussion) Injuries which are sufficiently severe to fracture the skull most frequently produce a longitudinal fracture line without displacement of any fragments This often occurs in the base of the skull and produces concussion of the brain usually accompanied by bleeding from the ears and nose and black and blue discoloration (ecchymosis) about the eyes (see Chapter 16)

Thirteen of the bones of the face are firmly attached to each other and to the cranium They form protective cavities for the eyes and nasal passages In some of these bones are cavities (*sinuses*) which increase vocal resonance and give a maximum amount of strength to the bones in proportion to their weight The fourteenth bone forms the lower jaw (*mandible*) and is the only one with well developed joints The inner surface of this bone is closely covered by the mucous membrane lining the mouth Nearly all fractures of the mandible tear the mucous membrane covering it thus causing an open fracture and increasing the danger of infection

Trunk. The main supporting bony structure of the trunk of the body is the spine This is made up of 33 bones called *vertebrae* fastened together to form a strong but somewhat flexible column On the upper end rests the head attached to the lower end are the bones of the pelvis Each vertebra consists of a disc-shaped body behind which is a ring of bone which forms a canal for the spinal cord A number of bony projections extend from this ring for the attachment of muscles and tendons and to partially lock the vertebrae together so that one cannot slide upon the next and thus

encroach upon and injure the spinal cord Firm pads of cartilage lie between the bodies of the vertebrae to serve as cushions and to permit some motion of the spine Because the spine bears much strain it must be strongly supported This is accomplished by strong tendons and ligaments and by powerful back muscles Although little motion is permitted between any two vertebrae, the combined motion allowed by all of the joints of the spine gives a considerable range of motion A pair of nerves passes from the spinal cord and between adjacent vertebrae on each side

The spinal column is divided into five portions 1, the cervical (neck) composed of seven vertebrae 2, the thoracic (chest) composed of twelve, 3, the lumbar (abdominal) composed of five, 4, the sacral (pelvic) composed of five vertebrae which are fused together into one bone (sacrum), and 5, four coccygeal bones forming a rudimentary tail

The bones of the neck permit a greater range of motion than other portions of the spine and enable us to turn our heads sideways (rotation) as well as to bend it forward and backward (flexion and extension) The neck contains many other important structures including the larynx (voice box), trachea (windpipe), esophagus, thyroid gland, and the blood vessels supplying the head Injuries to the neck which damage these structures usually are very serious

The *thorax* is composed of a bony cage made up of the twelve thoracic vertebrae twelve *ribs* on each side, and the *sternum* (breast bone) Joints exist between the ribs and spine which permit rotation of the ribs The ribs are attached to the sternum by means of cartilage which also allows some motion Muscles extend between the ribs and cover them By their action the ribs are elevated and lowered swinging on their hinged ends This motion increases and decreases the capacity of the thoracic cavity The lower surface of the thoracic cavity is covered by a dome shaped muscle the *diaphragm* which separates the thoracic from the abdominal cavity Contraction of this muscle also increases the air capacity of the chest This change in volume of the thoracic cavity is essential to our breathing as the increasing volume sucks air into the lungs and the diminishing capacity forces air out

Within the chest cavity are the lungs the right composed of three lobes the left of two the air passages the heart and its connecting blood vessels and the esophagus which connects the mouth with the stomach

The *abdomen* and *pelvis* are supported by the lumbar spine and bony pelvis These are supported by powerful spinal and back muscles and by the abdominal muscles which are arranged in layers running in different directions to give support to the abdominal organs and to aid in move-

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The *abdomen* and *pelvis* are supported by the lumbar spine and bony pelvis These are supported by powerful spinal and back muscles and by the abdominal muscles which are arranged in layers running in different directions to give support to the abdominal organs and to aid in move-

ments of the trunk The abdominopelvic cavity contains a number of hollow organs including the stomach, intestines, gallbladder, and urinary bladder, it likewise contains such solid organs as the liver, spleen, pancreas, and kidneys Because the diaphragm, which forms the upper limit of the abdominal cavity, arches up into the thoracic cavity, the lower ribs offer protection to some of the abdominal organs, especially the liver, spleen, stomach, and kidneys These organs, however, are likely to be injured if a blow or crushing injury strikes or fractures the overlying ribs

The entire body is covered by the *skin* and its appendages This serves to protect and support the underlying tissues It also serves as an excretory organ by means of the sweat glands The regulation of body temperature is partially controlled by the skin due to the dilatation or contraction of its blood vessels thus regulating the amount of radiation of body heat

CIRCULATORY SYSTEM

In discussing the anatomy of the body we have stated that the smallest unit is the cell Each cell maintains itself to the extent of developing its own heat and energy, nourishing and repairing itself, and reproducing To do this it must have at its disposal food and oxygen (fuel) and must be able to dispose of its waste products The circulatory system is the transportation system of the body which brings supplies to the cells and carries away waste products It consists of the heart, which pumps the blood and is thus the motivating force a closed system of vessels the arteries, capillaries and veins and the blood itself The liquid portion of the blood is able to pass through the capillary walls and between the cells to deliver oxygen and food to them and to take away their waste products

Blood This is a very important body fluid (which really must be classified as a tissue) and constitutes about one thirteenth of our body weight It may be divided roughly into the solid portion which constitutes nearly half its volume and the liquid portion The solid portion consists mainly of *red blood cells* (erythrocytes) *white blood cells* (leukocytes), and blood *platelets* all of which are microscopic in size In each cubic millimeter (small drop) of blood there are normally about five million red blood cells each cell being disc-shaped and concave on each side They do not possess nuclei and consist chiefly of a limiting membrane containing hemoglobin an iron protein compound Hemoglobin readily combines with oxygen in the lungs and carries it to the cells of the body where it gives it up in exchange for carbon dioxide which is a waste product of the cells It then carries the carbon dioxide to the lungs where it is given

off and expelled in our expired breath (see Chapter 14) The life of red blood cells is very short and they are constantly replaced by new ones which develop in the bone marrow

White blood cells (leukocytes) number from six to eight thousand in each cubic millimeter of blood There are a number of kinds of leukocytes, but the chief functions of all are to defend the body against foreign bodies such as bacteria by engulfing and destroying them, and to aid in the repair of damaged body tissue When infection occurs in the body the number of white blood cells rapidly increases (leukocytosis) to help combat it and may reach twenty or thirty thousand or more in each cubic millimeter Platelets are small bodies numbering about a quarter of a million to the cubic millimeter They are important in the clotting of blood

The liquid portion of the blood is called *plasma* Nearly 90 per cent of it is water This is essential to make the blood sufficiently fluid to flow readily in the vascular system, to carry sufficient materials in solution to supply the body cells, and to carry away waste products through the excretory organs Blood proteins, chiefly albumin and globulin, constitute about 7 per cent of plasma and remain fairly constant in amount under healthy conditions Another protein, fibrinogen, remains in solution in the blood vessels but solidifies in wounds and aids in clot formation Sodium chloride (salt) and other inorganic salts constitute nearly 1 per cent of blood plasma and are very important to life They are essential to the chemistry of the body, helping to maintain a constant acid base balance of the blood and preventing either acidosis or alkalosis from developing They also aid in carrying carbon dioxide from the tissues to the lungs

As body cells contain protein, they need material to build or synthesize protein within themselves This material the amino acids, is carried in the plasma from the intestinal tract, where it is obtained as a product of digestion and is transported to the cells Likewise, certain nitrogenous waste products as urea uric acid, and creatinine are carried from the tissues to the organs of excretion chiefly to the kidneys The main source of heat and energy for the body is sugar This is absorbed from the intestine in the form of glucose, stored in the liver as glycogen and is converted into glucose and returned to the blood as it is needed Plasma contains about 0 1 per cent glucose varying somewhat with the time relationship to meals Other substances contained in plasma are enzymes and hormones and certain protective antibodies which help to protect us from disease

The clotting of blood is a complicated mechanism by which blood

solidifies when it escapes from the vascular system If this did not occur we would bleed to death from minor cuts or bruises Clotting results chiefly from the conversion of fibrinogen (a liquid) into fibrin (a solid), which seals off the bleeding area This conversion is due to the interaction of a number of agents from the blood (including fibrinogen, prothrombin calcium and platelets) and from the damaged tissues (including cephalin) If blood is allowed to stand in a tube, a clot will form which enmeshes the blood cells and leaves a yellowish clear fluid called *serum* Thus blood serum is blood plasma minus fibrinogen

The Heart This organ is the motor mechanism which supplies the power to force blood through the vascular system and plasma through the capillary walls to nourish the cells As there are two essential vascular systems the *pulmonary* (to the lungs) and the *systemic* (to the rest of the body) two pumps are provided one for each system Therefore, the heart is composed of two separate pumps the one on the right forcing blood through the pulmonary arteries to the lungs from which it is returned via the pulmonary veins to the left side of the heart The left pump in turn forces the blood through the aorta and throughout the systemic circulation from which it returns into the right side of the heart (see Fig 2) The heart is a muscular organ which lies in the mediastinum the space between the lungs in the thoracic cavity It is covered largely by the sternum (breast bone) with about one third to the right and two thirds to the left of the midline It slants obliquely downward to the left terminating in the apex which usually can be felt with each heart beat below the fifth rib just medial to the nipple line The top, or base of the heart is in the midchest and connects with the large blood vessels The heart is surrounded by a closely fitting sac (the pericardium), which contains a small amount of fluid which acts as a lubricant and permits the heart to beat with a minimum of friction Each side of the heart is composed of two chambers the *auricle* (atrium), which collects blood from the veins and helps fill the other chamber and the *ventricle* which is the real pump A valve is present between the auricle and ventricle, which closes when the latter contracts and prevents the blood from regurgitating into the auricle and veins The force exerted by the contracting heart is sufficiently strong to maintain movement of the blood overcome resistance to it and partially distend the elastic arteries This force with the resistance it meets creates a pressure in the arteries called *blood pressure* When the body is at rest the heart beats about 70 times per minute and pumps from one to two ounces of blood with each beat The increased demand for blood products caused by exertion is partially met by an increased heart rate Each

heart beat consists of a contraction of the auricle followed very quickly by contraction of the ventricle, then both remain at rest until the next beat

Blood Vessels There are three types of blood vessels 1, arteries, 2, capillaries, and 3, veins The *arteries,* which lead from the heart to the capillaries, have comparatively thick walls composed of three layers the inner (intima) forming a lining, the media containing smooth muscle and elastic tissue, and the outer (adventitia) forming an elastic protective covering Arteries diminish in size and repeatedly branch as they extend away from the heart and finally terminate in *capillaries* These are very small vessels only slightly larger in diameter than a red blood cell and are made up of a single layer of cells Between the cells, plasma can escape to nourish body cells and can return to the circulation to bring back waste material The flow of blood through capillaries is very slow and is under very little pressure Blood flows from the capillaries into small *veins* which gradually join with others to form larger veins which in turn empty into the vena cava leading to the heart Veins have walls composed of three layers, but they are much thinner than the walls of arteries of corresponding size

As the force of the heart beat is transmitted to the arteries, the pressure within them (blood pressure) is comparatively great It is determined by the strength of the heart beat, the resistance offered by the walls of the vessels themselves, and the amount and viscosity of the blood When the heart beats and pumps blood into arteries, the pressure rises, accelerating the flow of blood, dilating the arteries, and increasing the blood pressure to about that exerted by 120 millimeters of mercury At the conclusion of the beat the heart relaxes and blood pressure falls but is held to a minimum of about 80 millimeters of mercury by contraction of the arterial walls By the time blood reaches the capillaries, pressure from the heart is greatly diminished and when it reaches the veins it is almost entirely spent That is why bleeding from severed arteries is abundant and comes in spurts under pressure whereas bleeding from veins occurs in a slow steady ooze Pressure in the veins alone is inadequate to return blood to the heart and this return circulation is aided by action of skeletal muscles, negative pressure created in the chest with each inspiration, and dilatation of the heart after each beat

The *pulmonary circulation* receives its pumping action from the right side of the heart the right ventricle forcing blood through the pulmonary arteries into the capillaries where carbon dioxide is given off and oxygen absorbed The blood returns through the pulmonary veins to the left auricle to be pumped by the left ventricle through the systemic circulation

The *systemic circulation* originates in the left ventricle and goes from there into the aorta This arises from the top of the heart in the midportion of the chest, arches backward and extends downward adjacent to and in front of the spine throughout the thoracic and abdominal cavities finally to divide into the two common iliac arteries (see Fig 2) The first arteries given off from the aorta are the *coronary* arteries, which carry blood to nourish the heart muscle itself These vessels are rarely injured accident ally, but an interference with their circulation by spasm or blood clots may cause sudden heart attacks, which frequently are met with by a first aid worker From the arch of the aorta, blood vessels are given off which supply the head and upper extremities, on the right side the innominate artery arises from the aorta and divides into the *right common carotid* and *right subclavian arteries* The *left common carotid* and *left subclavian arteries* arise separately from the aortic arch The common carotid arteries pass up the neck on each side of the trachea (windpipe) where their pulsa tions can be readily felt Fortunately, this artery lies deep enough so that the average cut or injury to the neck rarely penetrates it When the com mon carotid artery is divided, fatal bleeding is likely to occur unless *immediate* first aid care is given High in the neck, the common carotid divides into two branches the *internal* and *external* carotid The internal carotid artery passes into the skull where it helps to nourish the brain The external carotid artery gives off branches which supply the face, head and muscles of the scalp It continues on upward in front of the ear where it can be felt as the superficial *temporal* artery A branch the external *maxillary* (facial) artery passes over the lower border of the jaw slightly in front of the angle to supply the lower portion of the face The sub clavian artery passes laterally behind and slightly below the collar bone It can be felt at the base of the neck back of the collar bone where the artery passes over the first rib Before reaching this position it gives off the *vertebral* artery which passes up into the skull to help nourish the brain The subclavian artery continues through the axilla as the *axillary* artery then courses down the arm on the medial side of the humerus as the *brachial* artery which passes in front of the elbow joint Slightly below this it divides into the *radial* and *ulnar* arteries (see Fig 3) These course downward on the forearm and can be readily felt on the anterior surface of the wrist Both of these arteries supply branches which extend to the hand and fingers and unite with each other

In the thoracic cavity the aorta gives off *intercostal* arteries paired vessels which extend laterally under the border of each rib They com-

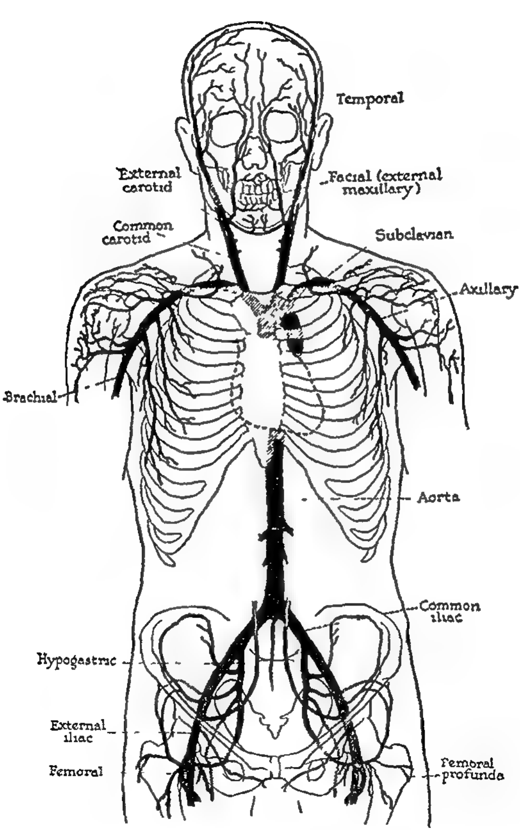

Fig 2 Main arteries of the chest and abdomen

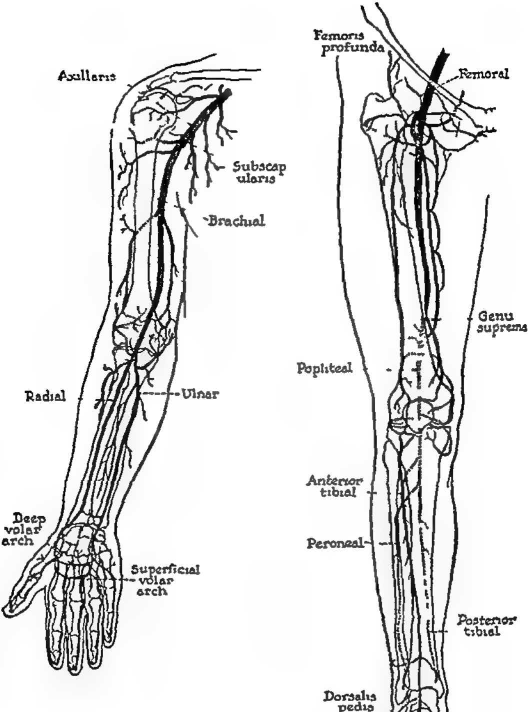

Fig 3 Main arteries of the extremities

municate in front with branches of the *internal mammary* arteries, which arise from the subclavian arteries and extend downward inside the anterior chest wall Penetrating wounds of the chest very frequently sever the intercostal arteries and produce bleeding to the surface or into the chest Penetrating wounds in the front of the chest wall often sever the internal mammary arteries Bleeding from these vessels may be serious, especially if blood flows into the chest cavity The thoracic aorta sends arteries to the esophagus, bronchial tree, and diaphragm In the abdomen, the aorta gives off arteries to the liver, spleen, stomach, intestines, kidneys, regenerative and other organs, and to regional muscles As these vessels are deeply placed in the abdominal cavity, being protected in front by the abdominal viscera and behind by the spine and spinal muscles, they rarely are injured The abdominal aorta terminates by dividing into the right and left *common iliac* arteries at about the level of the fourth lumbar vertebra The *hypogastric* artery (internal iliac) branches to supply blood to the pelvic organs including the regenerative organs, bladder, and rectum The *external iliac* artery continues downward and passes over the anterior ramus of the pubis and under Poupart s ligament The vessel is fairly superficial in the groin and its pulsation can be readily felt In this region and in the thigh, it is called the *femoral* artery It continues down the anteromedial portion of the thigh, becoming more deeply placed and giving off numerous branches to the muscles It passes medial to the lower third of the femur extends behind the knee in the popliteal space where it becomes the *popliteal* artery Slightly below the knee it divides into the *anterior* and *posterior tibial* arteries The anterior tibial artery courses down between the tibia and fibula and becomes superficial over the anterior surface of the ankle where its pulsation can be felt The posterior tibial artery passes down the posterior surface of the leg, is deeply placed and gives a number of branches to the muscles It becomes superficial as it passes around the medial malleolus and gives branches to the foot and toes

In general, arteries are accompanied by corresponding *veins* In addition to these veins however there are many superficial veins which can be seen coursing under the skin In the hand and forearm are many superficial veins (see Fig 4) which unite near the elbow to form the *basilic* and *cephalic* veins of the arm In the leg superficial veins empty posteriorly into the *small saphenous* vein which empties into the *popliteal* vein behind the knee Anteriorly and on the medial surface the *great saphenous* vein drains the superficial veins and empties into the *femoral* vein in the groin

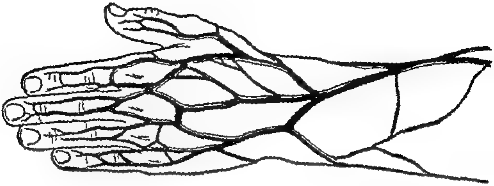

Fig 4 Illustration showing the veins of the dorsum of the hand and distal fore arm The veins are more numerous and superficial than the arteries here as in other parts of the body

Because of the superficial location of these veins, they are more easily divided than the arteries and thus lacerations are more likely to produce venous than severe arterial bleeding

RESPIRATORY SYSTEM

Respiration may be defined as the mechanism by which oxygen is supplied to the tissues and carbon dioxide is removed from them That exchange which occurs between the blood stream and body cells is spoken of as *internal respiration* The exchange between atmospheric air and the blood is spoken of as *external respiration* This is carried on in the respiratory system, which consists of the nose and mouth, pharynx, larynx, trachea, bronchial tubes and lungs All but the latter are merely passageways for air to reach the lung tissue In them however the air is cleaned, warmed, and moistened The *nasal passages* contain protruding shelves of bone (turbinates) which are covered with mucous membrane and increase the surface available for moistening and warming the air Hairs also are present to filter out the larger particles of dirt The *pharynx* the cavity back of the nose and mouth connects these cavities with the esophagus leading to the stomach and the larynx, leading to the lungs The *larynx* (voice box) has a valvelike cover (epiglottis) which opens when we breathe to let air into the lungs but closes when we swallow so that food and liquids will not enter The larynx is very prominent in males and is spoken of as the Adam s apple It contains the vocal cords which assist in speaking Below the larynx is the *trachea* (windpipe), which descends into the thoracic cavity and divides into the right and left main bronchial

tubes leading to the corresponding lung The *bronchial* tubes branch into smaller and smaller ones which finally lead to the *alveoli* and air sacs These are honeycomb like spaces lined with a membrane which is in intimate contact with blood capillaries and which permits an exchange of gases between air and blood (see also Chapters 13 and 14) As most of the oxygen in the lungs would soon be absorbed if the air were not replaced, the lungs are constantly emptied and refilled by breathing

Breathing is accomplished by increasing and decreasing the volume capacity of the thoracic cavity This in turn expands and contracts the lungs The act of increasing thoracic volume is called *inspiration* and is accomplished by the contraction of muscles which elevate the ribs and also by contraction of the diaphragm, which depresses itself Relaxation of the diaphragm and depression of the ribs forces air out of the lungs (*expiration*) There may be a difference in lung capacity of over four quarts between forced expiration and maximum inspiration This is called vital capacity and is about eight times as great as the normal exchange during quiet breathing

The *lungs* are located on each side of the mediastinum, the central area of the chest cavity containing the heart great vessels, gullet, and bronchial tubes Blood vessels and bronchi enter the medial surface of each lung in an area called the hilus Each lung is surrounded by a closed sac invaginated into itself (*pleura*) One side of the sac covers the lung the other covers the inside of the chest cavity This pleural sac contains only a small quantity of fluid and is air tight Thus when the chest wall expands, the negative pressure or vacuum expands the lung and air rushes into it through the air passages If an accident makes an opening into the pleural cavity so that air can enter it either from the lung or through the chest wall the vacuum will be broken and the lung will partially collapse Until the vacuum is again established that lung will receive little air to carry on the function of respiration Bleeding into the pleural cavity also can compress the lung and disturb respiration

Anything which will interfere with the exchange of gases between the blood and body cells will produce *asphyxia* Many things may interfere with external respiration Obstruction to the nose and mouth by gags or blockage of the larynx or trachea by a foreign body may cut off the supply of external air Inspired gases devoid of oxygen or containing poisons which interfere with the proper exchange of gases will produce asphyxia Filling the lungs with fluid (drowning) will have a similar effect Paralysis of the nerves which initiate expansion of the chest as results from certain diseases injuries, or poisons will disturb respiration

Diminished lung capacity from the presence of air, fluid, or blood in the pleural cavity, if sufficiently great, will cause partial asphyxia The lung may also be compressed by herniation of abdominal viscera through tears in the diaphragm Internal respiration may be interfered with by disturbances of the circulatory system Thus heart failure, anemia, blood loss, shock and altered blood chemistry, all can be factors in asphyxia

DIGESTIVE SYSTEM

Two essentials for the maintenance of life are oxygen and food The digestive system of the body receives and prepares food, reducing it or converting it into products which can be utilized by the cells of the body for the production of heat and energy, and for growth and repair It includes the alimentary tract with the teeth, mouth, pharynx, esophagus, stomach, small and large intestines, and the associated organs of digestion, the salivary glands, liver and pancreas In the head we have the teeth mouth, tongue, and salivary glands all of which aid in the proper mastication of food the breaking down of large food particles and their mixture with saliva to aid in some phases of digestion and to permit swallowing The *esophagus* which extends from the pharynx to the stomach passes through the posterior portion of the mediastinum directly behind the windpipe and in front of the spine and then going slightly to the left, passes through an opening in the left side of the diaphragm The facial and neck portions of the alimentary canal generally are not of much concern to a person administering first aid as they rarely are injured and if so more important considerations are met with However, one must remember that injuries in these regions may interfere with swallowing and in administering fluids care must be taken to avoid their passage into the trachea The great bulk of the digestive system is located in the abdominal cavity The *stomach* lies high under the left diaphragm and is protected by the lower left ribs (see Fig 5) The lower portion of the stomach (pylorus) crosses in front of the spine to empty into the first portion of the small intestine, the duodenum Severe blows to the upper abdomen or crushing injuries to the left lower chest may readily puncture the stomach especially if it is filled with food or fluids The *duodenum*, the first portion of the small intestine lies partially behind the peritoneum and is relatively fixed As it also lies in proximity to the spine, a severe blow in the upper portion of the abdomen may damage or rupture it The remainder of the *small intestine* which is about twenty feet in length, floats freely in the abdominal cavity suspended by a sheet of tissue, the mesen-

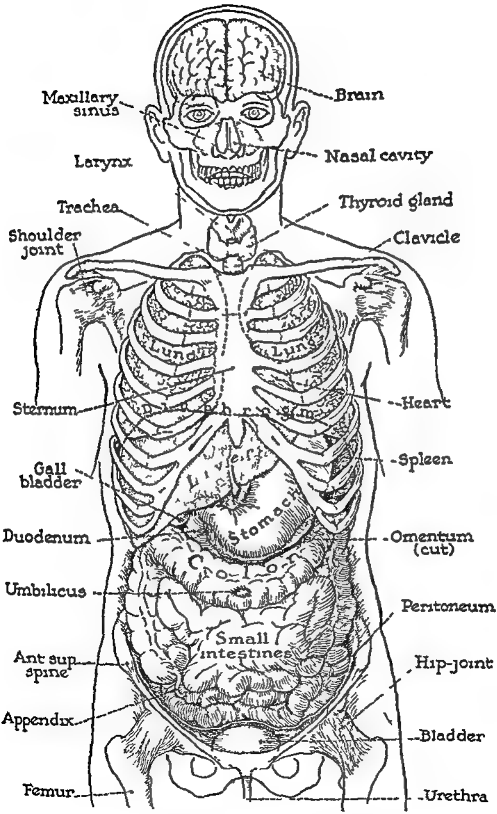

Fig 5 Anterior view of torso and head showing relationship of the organs

tery, between the leaves of which run the blood vessels supplying it Injury by blunt force to the abdomen is less likely to damage this portion of the small intestine However, because it has no bony protection either in front or on the sides and because it occupies such a large part of the abdominal cavity, penetrating wounds of the abdomen usually will puncture the small intestine The *large intestine* (colon), which is about five feet in length, extends up the right side of the abdomen, across the upper portion, and down the left side to enter the pelvic cavity and terminate at the anus Most of it is less mobile than the small intestine and it is partially protected by the pelvis, ribs and back muscles The *liver* which is the largest single organ in the body lies in the right upper abdomen filling the space under the diaphragm down to the lower level of the ribs It has a left lobe which extends across the midline partially to underlie the left diaphragm (Fig 5) This organ receives considerable protection from the ribs in front and the spine posteriorly However crushing injuries to the abdomen and lower chest are likely to rupture the liver, producing serious and frequently fatal results The *pancreas* an elongated digestive organ, lies directly in front of the spine crossing it transversely in the upper abdomen It is partially surrounded by the duodenum, is covered by peritoneum, and lies behind the stomach As a result, it is protected posteriorly by the spine and back muscles and is protected anteriorly by the overlying abdominal viscera and abdominal wall Consequently it rarely is injured

Another intra abdominal organ which is not a part of the digestive system but which might be mentioned at this time because of its frequent injury is the *spleen* This organ a part of the lymphatic system lies under the left diaphragm laterally and posteriorly It is close to the left lower ribs and fractures of these ribs frequently injure the spleen This organ also may be ruptured by a blow over it which does not fracture the ribs

Food entering the stomach generally is retained for several hours to be mixed with gastric secretion important to digestion It then passes into the duodenum where it is mixed with the highly active digestive juices produced in the pancreas as well as with bile from the liver and duodenal secretion Throughout the remainder of the small intestine food is propelled by peristaltic action and during this passage is gradually broken down by digestive ferments into suitable end products which are absorbed by the intestinal wall and carried by the blood stream to their place of destination These end products of digestion consist mainly of water inorganic salts sugar (glucose), amino acids (the end products of protein digestion) and fats Inorganic salts are utilized to maintain

the proper chemical balance of the body Glucose is the main fuel for the production of heat and energy It is carried from the intestines through a network of veins into the portal vein, which empties into the liver Here it is stored in the form of glycogen until needed to maintain a proper level of sugar in the blood As the body cells utilize the sugar in the blood replacement takes place from the glycogen in the liver In other words, the liver is an automatic stoker which furnishes a constant supply of fuel to the body cells by means of the blood Glycogen is also stored in the muscles for their own use The amino acids are very important for the growth and repair of body cells and a prolonged shortage of them will prove serious to the patient Fats are primarily a source of energy and generally are stored until needed Their absorption from the intestinal tract is made possible by the action of bile salts manufactured in the liver

The main function of the large intestine is the absorption of water from bowel contents, digestion and absorption of food products having been nearly completed in the small intestine Some mucus is secreted by the colon and mixes with the bowel contents, which then are stored in the lower colon until the time of evacuation The danger of damage to the gastrointestinal tract, as well as to any other hollow organ in the abdominal cavity when the abdomen is traumatized is directly proportional to the degree of distention by food or fluid

URINARY SYSTEM

In order to regulate the chemistry and composition of the blood and body tissues certain products must be eliminated from the body These include excesses of water and inorganic salts and waste products of cell metabolism Water is given off in fairly large quantities by the lungs This may amount to a quart or more a day The skin gives off water and certain salts through the sweat glands Some undesirable products such as poisons and heavy metals are removed from the blood by the liver The main organs however which purify the blood are the *kidneys* These organs are very important in the maintenance of a proper fluid and chemical balance of the blood When excessive amounts of water are absorbed from the intestine into the blood the kidneys will rapidly remove it When the body is depleted in water the kidneys will remove very little They remove many inorganic salts when they are excessive but will not disturb them if they are needed for chemical balance Certain nitrogenous waste products resulting from the utilization of amino acids are secreted by the kidneys These include urea uric acid and creatinine The amino acids

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posed of the brain and spinal cord, and the *peripheral nervous system*, composed of the cranial, spinal, and autonomic nerves

The *brain* fills the cranial cavity Its function is to coordinate the activities of the entire body as well as to generate thinking power and direct much of our body activity according to our will It is divided into a number of parts, each performing a definite function Nourishment is supplied by arteries entering through the base of the skull A clear fluid escapes from a plexus of arteries in the brain to fill spaces in the brain called ventricles and to cover the surface of the brain and pass down around the spinal cord This *cerebrospinal fluid aids* in nourishing the brain and spinal cord and acts as a buffer medium between the bone and nerve tissue to disseminate the force of impact and diminish injury to nerve tissue Brain tissue is easily injured and has little power of recovery Impairment of its circulation for a short time will cause irreparable damage For this reason it is supplied with an abundance of blood vessels and its blood supply is maintained at the expense of all other parts of the body except the heart itself The skull is so constructed as to offer a maximum of protection in proportion to its weight, and severe trauma is necessary to fracture the skull and injure the brain Likewise most of the blood vessels are well protected and rarely are ruptured The middle meningeal artery, which runs for a short distance in the temporal bone may be severed in fractures of this bone and produce a hemorrhage over the brain often causing paralysis of the opposite side of the body

Twelve pairs of *cranial nerves* emerge from the brain They supply chiefly the organs of special senses such as the eyes ears, nose, tongue, and vestibular apparatus (for equilibrium) and their associated muscles They also control the muscles of the face and transmit sensations from the face to the brain Some of these nerves may be damaged in skull injuries (See also Chapter 16)

The *spinal cord* extends down the spinal canal (within the vertebral column) to the level of the fifth lumbar vertebra (see Fig 98) It is surrounded by spinal fluid and by membranous coverings It gives off 31 pairs of nerves which extend out between the vertebrae on each side to reach and supply all parts of the skeletal muscle system of the body and the skin The *spinal nerves* control the action of these muscles (voluntary motion) and enable us to perform willful physical acts They also receive all sensation such as pain temperature touch pressure and vibration, and carry these impulses to the spinal cord and brain Division of any nerve will cause loss of sensation in any part of the body from which it carries sensory fibers and will cause paralysis of all muscles to which it

which are not needed by the body cells are broken down in the liver into glucose, which is stored as glycogen, and urea, which is secreted by the kidneys

We possess two kidneys, one lying on either side of the upper lumbar spine against the posterior wall of the abdomen Each kidney is about four inches long and shaped like a kidney bean with its concave side toward the spine The kidneys lie in front of the back muscles, which offer some protection and are covered anteriorly by the parietal peritoneum (lining of the abdominal cavity) Each is supplied by an artery from the abdominal aorta and sends a vein to the inferior vena cava The urine secreted by the kidneys is collected in a funnel-shaped sac (*kidney pelvis*) extending from the medial side of the organ This empties into the *ureter* a long tube leading to the bladder The ureters extend downward on the posterior abdominal wall on each side of the spine cross over the brim of the pelvis, course around the inside of the pelvis to empty into the bladder The *bladder* is a muscular sac lined with mucous membrane and covered on the outside with peritoneum When empty it lies entirely in the pelvis directly behind the pubis (the front part of the pelvic bone) Behind it in men is the rectum, and in women, the uterus When the bladder is distended with urine it extends up into the abdominal cavity and can be felt above the pubis

Because of the deep location of the kidneys and their protection behind by the spine and heavy back muscles injury to them is infrequent Occasionally severe trauma will rupture them producing hemorrhage into the back and flank The ureters are also well protected and seldom are injured The bladder however, because of its more vulnerable location and its exposure to trauma, especially when distended, frequently is ruptured This often accompanies fracture of the pelvis

The bladder is emptied through the *urethra* This is a short duct in women but is much longer in males and is surrounded by the prostate gland and other structures Straddle injuries especially in males, frequently injure or rupture the urethra and result in extravasation of urine into the surrounding tissues

NERVOUS SYSTEM

Although each cell of the body carries on its own metabolism and each organ has its own function these activities must be coordinated for the body to function as a unit This is accomplished by the nervous system We may divide the nervous system into the *central nervous system* com-

4

Bandaging

WARREN H COLE

Various types of bandages are available, but the one most commonly used is the ordinary rolled gauze bandage During recent years, elastic bandages of two types have been introduced 1, a bandage in which the elasticity is furnished by the type of weave in the cloth, e g , Ace bandage, and 2, a bandage in which the elasticity is furnished by rubber Either will maintain pressure, but experience in their application is necessary before general usage is recommended because the inexperienced worker usually applies them too tightly The so-called triangular bandage made from any type of cloth and folded forming a cravat 2 to 4 inches wide (see Fig 6) is rarely used in hospitals but may be very applicable to first aid work when roller bandages are not available The triangular bandage can be made from almost any type of cloth, muslin is inexpensive, strong and usually the material used

A *sling* is very useful in first aid work and consists in reality of a triangular bandage When used as a sling a square piece of cloth is folded to make a triangle, which is then applied to the upper extremity for immobilization of injuries of the hand, forearm, arm and shoulder (see Fig 7) The sling is applied by placing the base of the triangle under the wrist and the apex toward the elbow The arms of the sling are then carried upward around the neck and tied

Function of Bandages In general, bandages are applied for one or more of five purposes 1 asepsis 2, pressure to prevent bleeding, 3, fixation of dressing, 4 to increase the temperature of the part and 5, to anchor splints These points will be discussed later under Wounds

General Principles in Technic of Bandaging A few decades ago, bandaging was considered an important and necessary art in medicine In fact, a doctor s ability was commonly judged (erroneously) by the neatness of the bandages which he applied Since then we have learned that it is not necessary for a bandaged extremity to resemble a work of art to perform the function desired Naturally, neatness in the appearance

carries motor fibers If the spinal cord is severed or severely damaged as frequently occurs in fractures or dislocation of the spine, all nerves below the level of injury will be affected and the body below that region will be paralyzed and insensitive If the spinal cord is traumatized but not destroyed, partial and temporary paralysis may result and disturbed sensations, often increased sensitivity, may occur

The *autonomic nervous system* is not directly controlled by the will It directs the activity of our viscera (organs), controlling and regulating such things as heart action, intestinal motion, and secretion of digestive juices It also controls the smooth muscle in our vascular system, shunting the circulation to various parts of the body as needed In accidents where hemorrhage occurs it helps to prevent or delay the development of shock by contracting the blood vessels, diminishing the capacity of the vascular system, and thus maintaining blood pressure

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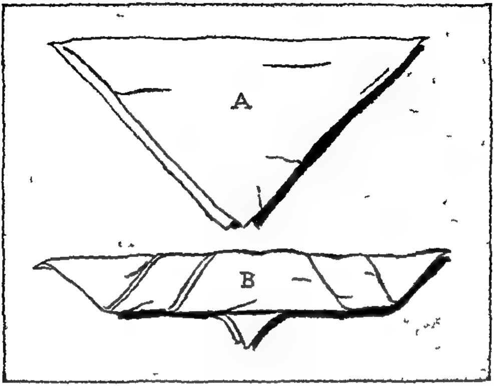

Fig 6 A, triangular bandage B bandage folded several times making cravat

of bandages is highly desired but there are so many other things in medicine more important that the student is no longer given special classwork in bandaging Since the need of attaining perfection in bandaging has been exaggerated the average doctor may be content with developing a sufficiently refined technic during his internship

Although a refined technic of bandaging can be acquired only by practice certain prerequisites must be understood and utilized *The most common error* in applying the ordinary type of bandage is that *it is applied too loosely* The bandage must be applied rather snugly since it stretches after a period of a few hours particularly if there is motion of the part It must be emphasized however that *if the bandage is applied too tightly the blood supply to the parts distal may be seriously interfered with*, resulting in grave complications including gangrene and paralysis Needless to say, the bandage must cover the wound Most bandages should be reinforced with adhesive to prevent shredding of the edges and to prevent undue stretching of the gauze Reinforcement with adhesive is the only

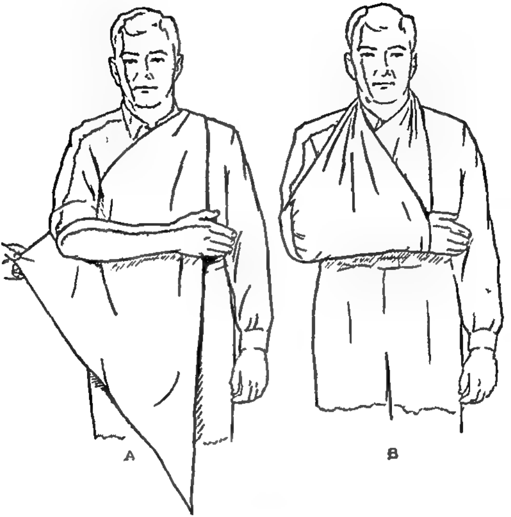

Fig 7 Sling made from triangular piece of cloth A the forearm is held in the position desired for carriage and the sling carried under it as shown B the arms of the cloth are tied behind the neck and the apex pinned to the sling in front of the elbow

method of maintaining consistent support unless an elastic bandage is used

When an open wound is present, a dressing will have been applied to the wound, fixation being attained by means of the bandage The bandage is applied by holding it with the roll uppermost taking a couple of turns around the extremity to anchor it and progressing upward or downward in a gradual way so as to leave no gap and yet distribute the bandage evenly Use as few turns as possible The bandage should be applied *with the limb in the position in which it is to be carried* The tips of the fingers

and toes should be left exposed wherever possible so that color changes may be observed As mentioned previously it is exceedingly important that the bandage not be applied too tightly Fortunately, numerous manifestations exhibit themselves to warn the doctor or attendant of undue constriction The color of the skin distal to the *bandage applied too tightly may be cyanotic (bluish) or pale Pain* usually is experienced within a few minutes after the application of a tight bandage A bandage which is too tight will produce *coldness of the extremity* and within an hour or two perhaps *numbness and tingling* It should be emphasized, however that after several hours, pain and discomfort produced by a tight bandage tend to disappear but when this occurs *severe damage has already been inflicted* This decrease in sensation usually implies that constriction of the blood supply is complete and has been present for several hours or long enough to numb sensation The resultant paralysis of muscles is apt to be permanent or nearly so and in severe cases actual gangrene results The consequences of a bandage applied too tightly, therefore are expressions of negligence and the doctor or attendant is held accordingly

There are several *fundamental turns* available for bandaging The *circular* turn is best adapted to cylindrical parts The turns are applied at right angles to the axis of the extremity and each turn directly overlies the previous one A bandage is spoken of as *spiral* when it covers the part in a spiral manner It may be applied to cylindrical portions of an extremity and is applied in such a way that each turn overlaps the other, finally attaining coverage for a relatively large area A *spiral reverse* bandage is particularly useful when the shape of the part to be bandaged is not cylindrical but slightly cone-shaped, for example the forearm If an ordinary spiral turn is taken on the forearm, the exposed edge will be loose producing an insecure bandage In order to overcome this looseness the bandage is reversed that is turned over 180 degrees at each turn of the bandage around the extremity as will be described later *Figure of eight* turns are very commonly used and can be applied to almost any portion of the extremities The bandage is anchored by one or two circular turns and two loops described in the form of a figure-of-eight (Figs 9, 11 and 12) *Recurrent turns* are useful in covering the scalp and ends of fingers (Fig 8) or extremities

Technics of Individual Types of Bandages One of the most common types of bandages used will be the *finger* bandage, since the hand is so frequently injured If the lesion is small application of a small sterile dressing which is covered with a few circular turns may be all that is required If the injury affects the end of the finger the tip naturally will

have to be covered This is done by utilizing a recurrent type of bandage after it is anchored at the base with a few circular turns (see Fig 8) The recurrent part of the bandage is accomplished by holding the bandage with the index finger of the left hand at the base where it has been anchored with the circular turns and bringing the bandage out over the tip of the finger to the other side The thumb then holds the bandage on the other side as it is returned to the original side Sufficient recurrent turns are taken to cover the fingertip as desired The edges of these recurrent turns are then covered with a circular type of bandage to anchor the edges The edge of the gauze must be anchored with a narrow strip of adhesive extending around the finger It must be anchored further, however, to prevent it from slipping off the finger This additional fixation is achieved by

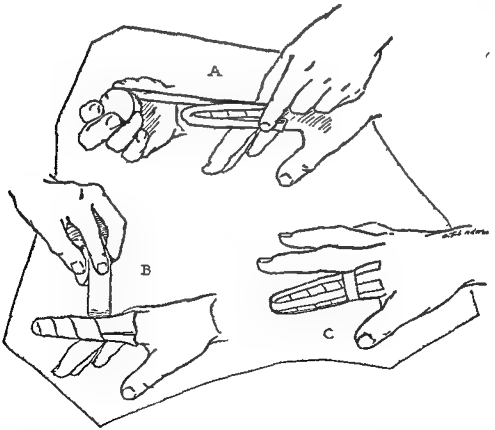

Fig 8 Recurrent bandage to the finger A the bandage is anchored with a few circular turns and then extended across the tip of the finger B the recurrent folds of bandage are anchored by circular turns C the bandage is fixed by the application of narrow strips of adhesive

a piece of narrow adhesive about 6 inches long, starting on the medial side and extending over the tip across to the lateral side onto the skin for a distance of 2 to 3 centimeters (see Fig 8) Application of such a strip on the anterior and posterior side of the finger will lend still more stability to the bandage If the injury extends onto the base of the finger or thumb a figure-of-eight type of bandage with one loop of the eight extending around the finger or thumb and the other loop extending across the palm of the hand or the wrist will be advisable (see Fig 9) This type of bandage limits mobility of the finger and hand, and is applied, therefore when immobility is desired

The *spiral reverse* bandage is applicable chiefly to portions of ex tremity which are conical and not cylindrical, e g, forearm, leg and thigh If the ordinary spiral bandage is applied to a conical portion of an extremity, it will be found that the edge of the bandage toward the smaller portion of the extremity will be loose thereby making the bandage un tidy and insecure The use of the spiral reverse principle obliterates this looseness Although the bulk of a dressing under the bandage will usually make the use of the spiral reverse principle unnecessary all the way up the extremity, the principle must be utilized for an occasional turn on most bandages applied to cone-shaped structures To apply it to the forearm the bandage is fixed at the wrist by two or three circular turns The bandage is then carried upward with a few spiral turns until the distal edge of the bandage becomes loose at this point the spiral reverse principle is utilized (see Fig 10) The bandage is turned over one-half turn holding the thumb at the point where the reverse begins Holding the thumb at this point or some point in the reverse fold will prevent the bandage from wrinkling and folding into untidy shapes A reverse is made with each turn of the bandage, executing the turn at the same place with each turn so as to maintain consistency and neatness

The *ankle* lends itself readily to a *figure of eight* type of bandage which may be applied to cover wounds or to lend support to a sprained ankle (see Fig 11) If the bandage is being applied for a sprained ankle, the foot should be held about in a right angle position, the bandage anchored with one or two circular turns around the foot, and continued upward across the anterior surface of the ankle, taking a turn or two around the distal part of the leg These turns in a figure of eight fashion are taken in sufficient number to cover the skin of the foot ankle, and distal half of the leg and to afford considerable immobility The end of the bandage is anchored with a circular turn of adhesive Since bandages tend to stretch to a degree largely proportionate to the length of time they

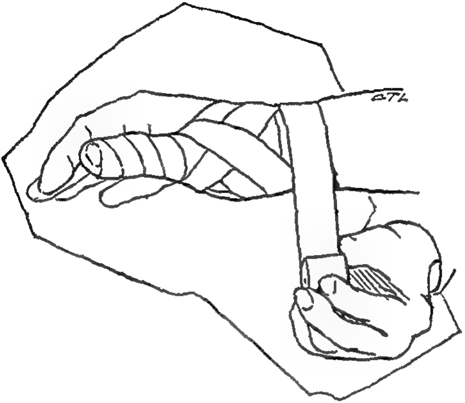

Fig 9 Figure of eight bandage to the thumb and wrist

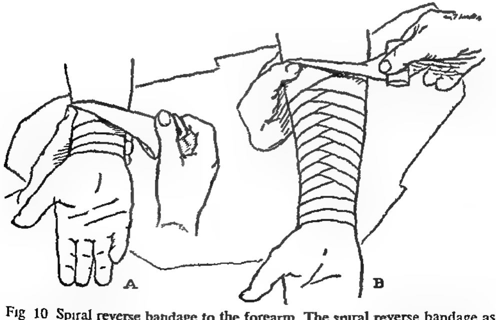

Fig 10 Spiral reverse bandage to the forearm The spiral reverse bandage as shown is used very little but its application is of teaching value since a reverse turn is needed now and then in many bandages to maintain neatness

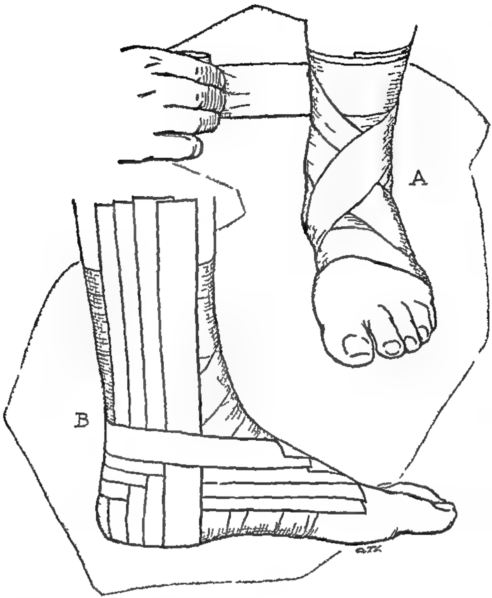

Fig 11 Bandaging the ankle A figure of eight bandage B to obtain a splinting effect as for example for a sprained ankle strips of adhesive are applied over the bandage as described in the text

have been on such bandages must be reinforced with adhesive if they are applied for a sprained ankle Strips of adhesive 1 inch wide and 12 to 18 inches long are utilized for this fixation The adhesive is anchored on the medial side of the ankle carried downward across the plantar surface of the foot, extending upward over the lateral and anterior surface of the

ankle, crossing toward the medial side of the leg and must be long enough to extend onto the skin for 2 to 3 inches It is important to apply the first strip of adhesive in this direction when a sprained ankle is being treated in order to obtain eversion or external rotation of the foot Fixing the ankle in eversion or external rotation puts the torn ligaments at rest and allows approximation of their edges, since the ligaments torn in a sprained ankle are usually those on the lateral surface The second strip of adhesive starts on the lateral side of the ankle, extends across the plantar surface of the foot toward the medial side of the ankle and upward across its anterior surface to the lateral side of the leg again extending 2 or 3 inches onto the skin Three or four more strips are applied on each side, overlapping each other sufficiently to incase most of the bandage in an adhesive covering Many doctors prefer to apply the adhesive directly to the skin when treating a sprained ankle This procedure, however, results in wrinkling of the adhesive which pinches the skin and becomes uncomfortable It does afford slightly greater immobility, but not to a very significant extent if the adhesive placed over the gauze bandage is anchored to the skin of the leg Unquestionably, the dressing with bandage underneath the adhesive is more comfortable and affords just about as much immobility of the ankle Such dressings will need to be changed in four to six days regardless of the type used When a sprained ankle is sustained in the woods or areas where little material is available, and when it is necessary for the injured person to walk home or to a source of transportation the cravat type of dressing may be utilized by applying it over the shoe The cravat is formed by folding cloth of any type several times to attain a width of about 3 inches If only short cloth is obtainable, pieces may be tied together This cravat is applied very tightly over the shoe in a figure-of-eight fashion and affords remarkably effective immobilization

The *figure-of-eight bandage to the neck and axilla* will be found useful to bandage wounds on the lateral side of the lower portion of the neck and for wounds over the clavicle (collar bone) or shoulder It is started by one or two circular turns around the neck for anchorage The bandage is then carried across the clavicle going under the arm (axilla) on either the anterior or posterior side (see Fig 12) It is then carried up over the clavicle crossing the bandage going to the axilla, and is extended around the neck The figure of-eight process is repeated as often as necessary and is overlapped sufficiently to cover the wound and its dressing It can, of course, be extended to the opposite axilla but need for doing so will probably be somewhat uncommon The *figure-of-eight bandage to the neck and thorax* will be found very useful in injuries of the lower part of the

Fig 12 Figure of eight bandage to the neck and axilla

anterior or posterior portions of the neck or in wounds of the anterior or posterior portion of the upper thorax The bandage is anchored by a turn or two around the neck and carried across the wound in the anterior or posterior portion of the chest, it is then extended halfway around the upper chest and is brought back to the neck The figure of-eight type of bandage in these areas will make the bandage more secure and lessen the danger of the bandage or dressing slipping away from the wound The figure-of-eight bandage is likewise very applicable to wounds of the hand and wrist, areas where injuries are very commonly sustained (see Fig 13)

When the side of the face or jaw is to be bandaged, the *oblique bandage of the jaw* is very applicable If the right side of the jaw is to be bandaged, the end of the roller bandage is placed on the right temple and

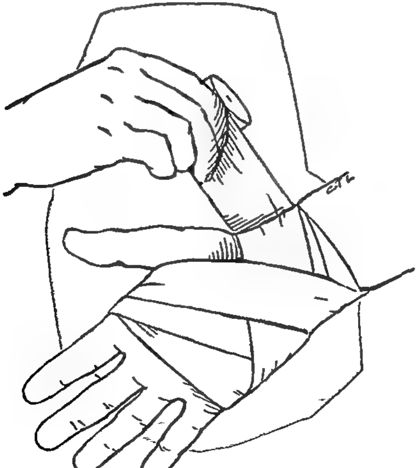

Fig 13 Figure of eight bandage to the hand and wrist

carried for two circular turns from before backward, around the head above the ears (see Fig 14) As the third turn arrives over the ear, the bandage is extended under the back of the head, forward under the jaw, up the right side of the face, between the ear and eye It is then extended over the dome of the head downward back of the left ear, under the jaw,

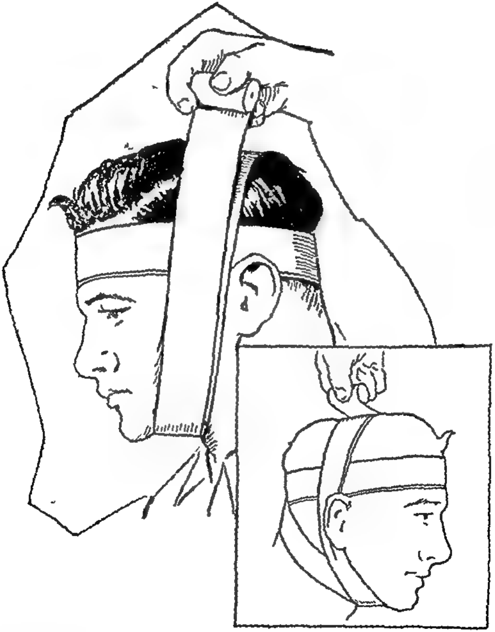

Fig 14 Oblique bandage to the jaw revealing appearance of the bandage on each side

and again up the right side of the face This process of extending turns around the vertex of the head and jaw and across the occipital region is repeated four or five times until the purpose of the bandage is accomplished This type of bandage can be used for a fracture of the jaw but before it is applied, the lower jaw should be pulled forward as much as possible so that it may be fixed by the bandage with relatively little overlapping of bony fragments This oblique bandage of the jaw is similar to the Barton Bandage which is *advised erroneously* for a fracture of the jaw by some surgeons The serious *defect of the Barton Bandage* is the combination of a turn around the anterior portion of the chin across the back of the neck with the oblique bandage This turn across the chin and back of the neck tends to increase the overlapping of bony fragments and pushes the tongue backward against the pharynx, thereby impinging on the air passage of the posterior pharynx If the patient is unconscious, such an error of bandaging the jaw backward may actually result in suffocation and death

The *recurrent bandage of the scalp* is particularly useful in fixing dressings to wounds over the vertex of the head After a sterile dressing is placed over the wound, a 2 inch bandage is started around the forehead and back of the head just above the ears, requiring two or three turns for fixation (see Fig 15) When the bandage reaches the midline anteriorly it is held in position by the patient or an assistant It is then

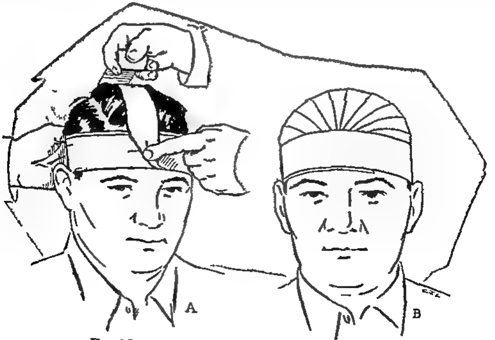

Fig 15 Recurrent bandage to the scalp and head

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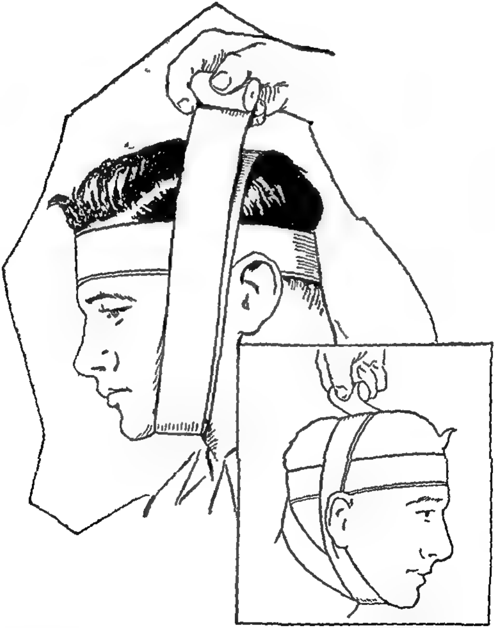

Fig 14 Oblique bandage to the jaw revealing appearance of the bandage on each side

of adhesive across the top of the head to prevent ruffling of the edges of the bandage In the absence of a roller bandage, the triangular bandage serves well to fix dressings to the head and prevent contamination to wounds of the scalp (see Fig 16)

The *figure-of-eight bandage to the eye* is useful in anchoring dressing over wounds about the eye, and to protect the eye from light It may, of course, be applied to either eye or both To bandage the left eye, the bandage should be started on the forehead, carried over the left ear, across the occiput (back of the head) to the starting point for anchorage It is then carried again back above the left ear, around the occiput, across the left eye and cheek, under the left ear (see Fig 17) Another complete circular turn around the forehead and occiput is made, followed by an oblique turn under the left ear across the face and eye This procedure is repeated as often as necessary to fix the bandage, overlapping of the turns will add to the coverage of the bandage The oblique turn across

Fig 17 Figure of-eight bandage to eye

extended directly posterior to the suboccipital region where the physician himself anchors it with his own left hand It is then carried back to the forehead, held in the position by the patient or an assistant, and returned again to the occiput Each strip extends across the vertex, overlaps the preceding one laterally so that the entire scalp region can be covered The loose ends at the front and back of the head then are anchored by two or three additional circular turns This bandage must be reinforced by a circular turn of 1-inch adhesive extending all the way around the fore head and occipital region If it is not fixed with adhesive, it will stretch and slip off the top of the head Usually it is advisable to put several strips

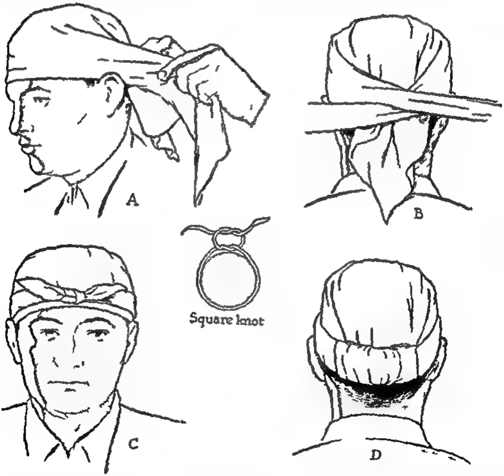

Fig 16 Application of triangular bandage to the head A the body of the bandage is placed over the forehead and the arms extended posteriorly cross ing over the occiput as shown in B C the arms tied over the forehead D the apex of the bandage is folded over the crossed arms

of bandage Such a dressing may be utilized for wounds in the upper thigh and lower abdomen It should control hemorrhage from all veins and most small arteries It will not control bleeding from the femoral artery If hemorrhage arises from this vessel, cessation of bleeding may be attained only by direct pressure (see Chapter 7) This direct pressure may have to be maintained until the patient is transported to an operating room

When bandages are not available numerous substitutes may be employed Sheets, pillow cases, shirts, etc , may be torn into strips of desired width and used as bandages Figure 19 illustrates the numerous uses which may be made of a substitute material, e g , a stocking

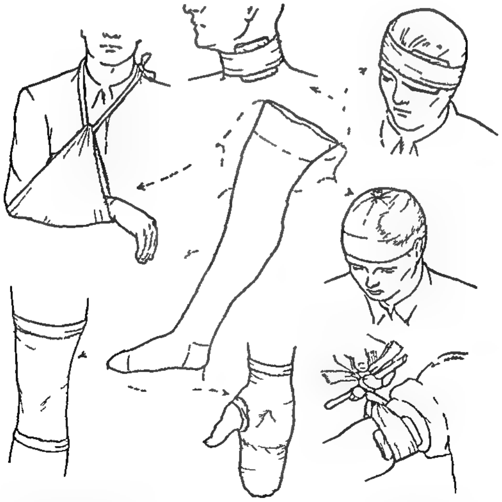

Fig 19 In the absence of complete availability of medical supplies numerous types of material may be utilized Illustration shows methods in which a stocking may be used to reinforce bandages and dressings

the eye should be fairly loose to prevent discomfort It frequently adds to comfort to place a piece of cotton or bandage behind as well as over the ear and to carry one or two turns across the ear, not under it

The *spica bandage of the hip* is useful in wounds of the groin especially when pressure is required to stop hemorrhage (see Fig 18) This spica bandage is in reality a figure-of eight bandage, one loop of the eight extending around the upper thigh and the other loop around the lower part of the abdomen, crossing in the groin By applying a bulky dressing in the groin considerable pressure against a bleeding point can be achieved This pressure can be maintained and actually increased by applying strips of adhesive in somewhat the same direction as the turns

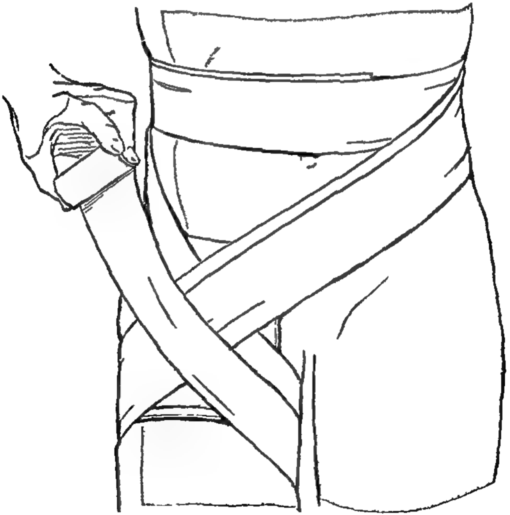

Fig 18 Spica bandage to the thigh and groin

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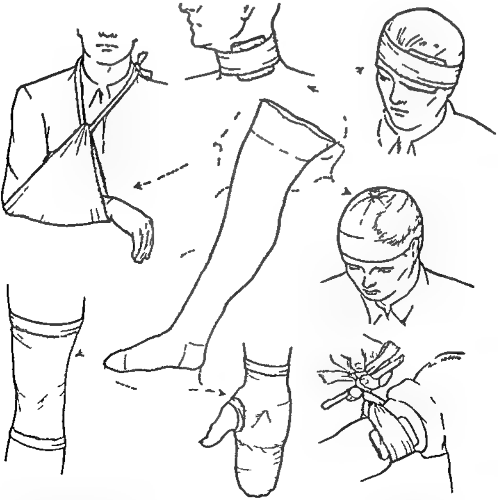

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5

Wounds

WARREN H COLE

TYPES OF WOUNDS

The mechanism by which the wound is inflicted and the degree of violence will determine the type of wound sustained The degree of contamination will be determined by the amount of foreign material (dirt etc) with which the wound comes in contact as it is inflicted Civilian wounds will contain a minimal amount of foreign bodies in contrast to war wounds, which usually contain foreign bodies (e g , shrapnel and bullets) The characteristics of war wounds will be discussed in Chapter 25

Wounds may be classified in two major groups viz contused (closed) and open *Contused wounds* result from the impact of blunt objects and although the skin is not penetrated there may be much crushing of tissues beneath the skin There is always a variable amount of hemorrhage which takes place at the time of injury, and frequently for a few hours thereafter The soft tissues may be lacerated (i e , torn) to a marked degree so that vital structures may be damaged frequently A variable amount of swelling develops 24 to 48 hours after infliction of the injury This swelling is due to hemorrhage and edema (i e , extravasation of serum) The blood clot which forms at the site of a contusion is spoken of as a *hematoma* The blood in the hematoma extravasates into surrounding tissues including the skin and produces the bluish discoloration spoken of as a bruise Over the course of a few days this bluish or bluish black color changes to a greenish or yellow color because of oxidation of the blood pigment

An *open wound* may be defined as one in which the skin is incised or torn, thus exposing the tissues beneath There are four major types of open wounds 1 An *abrasion* is the most superficial and least serious of the open wounds and consists of nothing more than a scratch over the skin surface without penetration of all the layers of the skin A small

amount of hemorrhage may take place as a result of an abrasion, but rarely more than a few drops Much dirt may be ground into the abrased surface 2 An *incised wound* is one made by a sharp object The edges of the skin or mucous membrane and underlying tissues severed will be smooth because of the sharpness of the object inflicting it Obviously, if such a wound is deep, important structures such as large blood vessels and nerves may be severed Such wounds bleed freely, the amount being determined by the location, with reference to the number and size of blood vessels severed 3 A *lacerated wound* is inflicted by a rather blunt object, but sufficiently sharp to tear the tissues As in an incised wound, important structures beneath the skin may be damaged By looking at the exterior of the wound it is usually impossible to determine what important structures may have been injured, since the edges will fall together obstructing visualization of the depth of the wound Obviously, if important blood vessels are severed the resultant hemorrhage will be ample evidence of vascular injury Usually the amount of hemorrhage in a lacerated wound is less than that produced by an incised wound This is true because the tearing and stretching of the tissues allow curling and folding of the blood vessel wall, thereby obstructing the lumen and resulting in more rapid and extensive blood clot formation 4 *Penetrating or punctured wounds* result from penetration of the skin or mucous membranes with a sharp object It will obviously be impossible from the appearance of the external wound to determine just how far the object penetrated A wound inflicted by a dagger may make a wound of entry no longer than 0 5 or 1 inch but may penetrate 3 or 4 inches cutting intestine lung liver or other organs, depending upon the site of injury

Obviously any of the open wounds just described may also be associated with a variable amount of contusion of tissue This is particularly true of lacerations which may be produced by relatively blunt objects This additional trauma retards healing

THE ILL EFFECTS OF WOUNDS

Contused Wounds Since contused wounds are not associated with superficial laceration they are not subject to the serious dangerous effects accompanying open wounds However, if the contusion is extensive there may be crushing injury of important structures as previously mentioned which may even result in death Intestinal loops may be crushed so severely as to be severed completely thereby requiring immediate operation to save life *Contused wounds involving the heart* may seriously affect

the conduction system, thereby altering the heart beat and perhaps even stopping it A rather frequent and serious complication or ill effect of contusions is a fracture, which may be located in any bone depending upon the site of injury Blood vessels may be severed, resulting in a variable amount of hemorrhage, depending upon the size of the vessel and type of therapy, if any, rendered immediately after the accident Since the brain is protected on all sides by bone, it would appear that contusion of the brain would be infrequent or even impossible However contusion of the brain accompanied by laceration and hemorrhage is quite common, because the blow may set up such rapid motion of the head that the stationary brain within is suddenly jammed against the skull on the side of the impact the other side may be injured by suction or negative pressure set up by the brain collapsing away from the outside wall of the skull opposite the site of injury If the motion of the head is suddenly stopped by striking a stationary object a contusion of the brain may be sustained on that side which usually will be the side opposite the site of the original blow Ordinarily, the thoracic cage protects the lungs, heart and great vessels from contused injury, but the ribs are so flexible (particularly in children) that the intrathoracic organs may be severely damaged by a crushing injury This effect will of course, be greater if several ribs are broken on each side, in which case the thoracic cage loses its protective quality

Fractures may be sustained even though very little evidence of soft tissue injury is manifest Considerable injury to adjacent tissue may be inflicted by the jagged bare ends of bone Since fractures usually require reduction and always require more time for healing than does disruption of most soft tissues an x ray is indicated if there is even suggestive evidence of a fracture

Open Wounds Many *effects and complications* may result from open wounds On many occasions these secondary effects will be more serious than the primary effects of the accident and may result in the patient s death Infection is a constant and serious hazard

HEMORRHAGE As already mentioned hemorrhage is one of the most serious effects of wounds and although of most significance at the time of injury, secondary hemorrhage may take place many hours after the injury When hemorrhage is secondary it is usually due to infection or to a second injury Obviously arterial hemorrhage is more serious than venous Arterial blood is bright red, contrasted to the dark red or bluish red color of the venous blood As will be discussed later in detail massive hemorrhage results in the development of shock, which requires immediate therapy to

save life About 8 per cent of the body weight is blood Loss of one half of this blood at one time is usually fatal

OPEN FRACTURES When the skin and subcutaneous tissues over a fracture are broken so that the fracture site connects with the exterior, the fracture is spoken of as *open or compound* This situation complicates tremendously the treatment of the fracture and likewise increases the difficulties from numerous aspects, including increase in complications, particularly infection and the consequent osteomyelitis The patient must be taken to the operating room immediately and the wound debrided (i e , necrotic tissue and foreign bodies removed) Details of open fractures will be presented later

INJURY TO SPECIAL STRUCTURES There is much more chance of injury to vital deep structures in open wounds than in closed wounds Injury to blood vessels has already been discussed Injuries to nerves and tendons are common and require careful examination for their demonstration and repair Laceration through a joint capsule requires careful attention and repair of the wound as soon as possible As previously mentioned it is difficult to determine from the external appearance of a wound just how deep it is For example, a foreign body may make only a small open wound penetrating the abdominal wall, but if it penetrates the intestine or severs a large vessel an abdominal operation will be necessary Omission of repair of such injuries leads to a needless fatality

INFECTION Infections are produced by bacteria, which are present everywhere except where sterilization has taken place The world owes this knowledge of the relationship of bacteria to infection to the noted French scientist Pasteur, whose first discoveries made no earlier than the middle of the last century, were based upon the demonstration of bacteria in the air This can be corroborated readily by exposure of an agar plate (for culturing bacteria) to the air for an hour or so and incubating for 24 or 48 hours Even in rooms which are kept clean as many as 50 to 200 colonies will grow indicating that this many bacteria dropped on a plate from the air It should be emphasized, however, that air is a trivial source of bacteria more of them being found on the various solid objects (clean or dirty) about us In spite of cleanliness, the human skin is teeming with bacteria The mouth contains even more bacteria many of which are very pathogenic (i e produce active serious infection) Fortunately the skin and mucous membranes offer a splendid protection against the invasion of organisms Only occasionally do bacteria penetrate these structures Tonsillitis furuncles and carbuncles may be mentioned as examples of spontaneous penetration of bacteria through the mucous membrane or skin

Many bacteria are not harmful to the human body and in fact are helpful to certain bodily functions such as digestion The most virulent common organisms affecting man are the *streptococci* and *staphylococci* The streptococcus is not as prevalent as the staphylococcus but is apt to produce a more serious infection, invading more rapidly, and is more apt to be fatal It can be found in the mouth of most people, frequently in large numbers, some strains such as the hemolytic streptococcus are exceedingly virulent The staphylococcus is very prevalent over the skin of the body and infection produced by it is not rapidly invasive, although serious The *colon bacillus* which is a constant inhabitant of the intestinal tract is likewise pathogenic to man if it enters body cavities or subcutaneous tissues The *tetanus bacillus* which produces tetanus (lockjaw), and the *gas bacillus* (several strains) which produces gas gangrene are spore-bearing organisms not readily killed by heat such as boiling water, and are very serious when they obtain a foothold in the body Even the latter two organisms are frequently present in the intestinal tract of man they are much more prevalent (particularly the tetanus bacillus) in the intestinal tract of animals thus accounting for a high incidence of development of tetanus (lockjaw) when wounds are inflicted about barnyards The tetanus bacillus and gas bacillus (e g , Welch bacillus) are anaerobic contrasted to the other organisms mentioned which are aerobic Anaerobic organisms grow without the presence of oxygen whereas aerobic organisms require oxygen for growth Because of these factors, punctured wounds are apt to result in the development of tetanus or gas gangrene particularly the former since oxygen does not have access to the depths of such a wound A simple punctured wound is not very apt to result in gas gangrene because massive destruction of tissue resulting in necrosis seems to be necessary for the development of gas gangrene Unquestionably the presence of aerobic organisms using up oxygen accelerates the development of either of the anaerobic infections mentioned

All wounds except those made in the operating room under aseptic conditions are contaminated with a variable number of bacteria Such wounds are spoken of as *contaminated wounds* After six to eight hours the bacteria begin to multiply profusely and penetrate the tissues beneath the surface At the end of 24 hours an obvious infection will have become manifest The wound is then spoken of as an *infected wound* Naturally, when wounds are inflicted on clean skin by a clean sharp object little contamination results An example of this trivial contamination would be incised wounds inflicted by broken glass while washing dishes Such

wounds will heal readily if given proper rest and other care On the contrary, *wounds which are inflicted by contact with the ground* and which contain many foreign bodies, such as dirt and bits of clothing, contain numerous organisms, in other words, they are severely contaminated and require expert care to prevent development of infection

MISCELLANEOUS COMPLICATIONS OR ILL EFFECTS Occasionally, the laceration or destruction of tissue is so massive that the tissue distal to the injury (i e , on an extremity) may become devitalized or gangrenous and *have to be amputated On other occasions the destruction of skin is so* massive that a skin graft may be necessary later It should be remembered *that almost any organ or structure near the wound may likewise be in*jured To obtain a satisfactory understanding of the possibility of such injuries an accurate knowledge of anatomy is necessary

TREATMENT OF WOUNDS

Contused Wounds The treatment of contused wounds consists of cold applications to discourage continuation of bleeding and the application of a pressure bandage Rest is likewise important, since activity would encourage continuation of hemorrhage and increase in size of the hematoma A day or so after the injury when all bleeding has stopped the application of heat which produces a dilatation of the blood vessels and an increased blood supply, will facilitate absorption of the blood clot

Open Wounds *Abrasions* might be classified as open wounds, but in reality the scratch or tear does not involve all the layers of the skin accordingly there is only slight danger of deep infection (i e , beneath the skin) If they are sustained under fairly clean circumstances, no treatment other than the application of a sterile dressing will be necessary If they are sustained under unclean circumstances, it will be preferable to wash the area gently with soap, water, and a clean cloth or sterile gauze sponge before the application of a sterile dressing, which can be purchased at most drug stores If dressed, a mild local antiseptic may be applied, however, since all antiseptics are usually injurious to body cells (even in the skin) they cannot be recommended as routine therapy in abrasions If infection should develop, therapy with one of the antibiotics such as penicillin or Aureomycin will be indicated (See Chapter 2 for details including dosage)

The *treatment of deep wounds* is much more complicated than the

treatment of contused wounds or abrasions As already discussed the most important immediate act in therapy of a deep wound is to stop hemorrhage Three procedures are available for the control of hemorrhage 1, application of a pressure dressing to the wound, which may require sustained pressure by the hand or finger for several minutes, 2, compression of the artery above the wound, and 3, application of a tourniquet If possible, the dressings used in the packing of a wound should be sterile otherwise a freshly ironed handkerchief or towel, which is unfolded to obtain an unexposed surface, may be used The unsterile hand should not be inserted into the wound Only on the rare occasion when no type of dressing is available may the hand be plunged into the wound for the purpose of stopping a serious hemorrhage it is obviously preferable to have a live patient with an infected wound than a dead patient with a clean wound

Usually, the application of a pressure dressing combined perhaps with compression of the artery proximal to the wound, will be sufficient to stop bleeding Only on rare occasions then will there be indications for the application of a tourniquet We wish to emphasize this point, particularly because *the indiscriminate use of tourniquets by amateurs in accident work will do more harm than good* this harm may result either from faulty application of the tourniquet or its use over too long a period of time The details of the methods for controlling hemorrhage by the methods just enumerated (including the application of the tourniquet) will be given in Chapter 7

If bleeding has ceased by the time the first aid attendant arrives he should *by no means disturb any blood clots* present, since their removal usually results in reactivation of the hemorrhage Sterile dressings should be applied, assuming they may be obtained within a few minutes While awaiting sterile dressings someone must watch the patient lest he contaminate his own wound with his hand and must likewise protect the wound (in summer) from insects of various types *No attempt should be made by the first aid attendant to wash out deep wounds* lest bleeding be reactivated or contamination be increased by lack of aseptic conditions If it is obvious that sterile dressings will not be available without a lot of delay a freshly ironed handkerchief or towel may be used for a dressing, unfolding it so that an unexposed surface may be applied to the wound

If the wound is badly contaminated chemotherapy may be instituted at once Several chemotherapeutic agents are effective when given orally (e g , tetracycline Aureomycin and Terramycin) but oral intake will be

contraindicated if a general anesthetic must be given for wound repair Numerous agents (particularly penicillin) can be given subcutaneously and intravenously, but seldom can these be given outside a hospital Since many individuals are sensitive to penicillin, it is usually wise to inquire concerning sensitivity before giving this drug Penicillin is very effective against gram positive bacteria, the most common organisms causing infections in open wounds If the wound is massive and badly contaminated as much as 1,000,000 units per day should be given hypodermically Oral administration is not very effective, but should be used if the intravenous route is not available or if no other agents are available The effective oral dose must be several times that listed above

Although the technic of operative repair described below consists of that which may have to be improvised on a camping trip with inadequate equipment, it should, nevertheless, be carried out only by physicians After control of hemorrhage the available instruments and supplies are sterilized The hands are scrubbed with soap and water and sterile gloves applied if available The skin around the wound is cleansed with soap and water, and the wound irrigated with sterile water (physiologic saline preferable if available) to remove dirt and blood clots (see Fig 20) The area surrounding the wound is draped with towels or cloth of some type made by boiling in water or heating in an oven Naturally some type of anesthesia will be necessary If Novocain (procaine) is available it will probably be the one of choice The solution is made in a concentration of 0 5 or 1 per cent by dissolving the crystals in the required amount of sterile water With the aid of a sterile syringe and needle, the edges of the wound are infiltrated with Novocain solution Any foreign bodies in the wound should then be removed Debridement, i e , excision of devitalized and contaminated tissue, is then performed Usually no subcutaneous sutures will be required except those necessary for ligation of blood vessels Either catgut or sterile cotton or silk may be used for these deep sutures, but if asepsis is poor catgut is preferable since the application of nonabsorbable sutures such as cotton or silk in an inadequately treated, contaminated wound may prolong the drainage accompanying the infection The skin is closed by a curved or straight cutting needle using fine cotton or silk These sutures may be either interrupted or continuous After the wound is closed a sterile dressing is applied Antitetanic serum (1,500 to 5 000 units) should be given If the wound is massive anti-gas gangrene serum should likewise be administered Sutures are left in wounds three to seven days dependent upon the location and amount of

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If the wound is badly contaminated chemotherapy may be instituted at once Several chemotherapeutic agents are effective when given orally (e g , tetracycline, Aureomycin and Terramycin) but oral intake will be

tension upon the wound edges They must be removed carefully lest infection be implanted along the suture tract (see Fig 21)

When the laceration is shallow and short, sutures need not be applied If the wound edges remain approximated, the application of a sterile dressing after perhaps washing the wound under a stream of running water, is all that need be done Numerous types of small sterile dressings with adhesive attached are on the market (see Fig 22) If none of these previously prepared dressings is available, a piece of sterile gauze may be cut from a larger piece as shown in Figure 23 Sterile pieces of folded gauze 2 to 3 inches in diameter (see Fig 23C) may be purchased at most drug stores, these simplify the problem of applying sterile dressings to any type of wound

When wound edges gape only slightly, they frequently may be approximated and held in position by a piece of adhesive folded in the center and applied as shown in Figure 24, after the central portion has been sterilized by being held over a flame

To offer further correlation for first aid workers and emphasize the importance of wound asepsis, a brief consideration of infected wounds is given below Infection is manifested by swelling, redness, increase in the temperature about the wound and a systemic reaction consisting of fever malaise, anorexia (loss of appetite), and perhaps weakness If it appears that infection of the wound is developing part of the sutures should be removed to allow drainage Heavy doses of a chemotherapeutic agent such as penicillin Aureomycin or tetracycline are indicated It is exceedingly important that *absolute rest* of the wounded part be obtained If the wound is on the lower extremity, the patient should not be allowed to walk if on the upper extremity it should be carried in a sling The patient must have ample fluids and an adequate intake of easily digestible foods *Do nothing to traumatize or irritate the wound Be gentle in all movements*

War Wounds As stated previously war wounds differ from wounds seen in civilian life insofar as tissue destruction is greater more dirt and foreign bodies are buried beneath the tissue and a greater length of time between injury and operative repair usually exists These differences exert a marked change in the methods of treatment which are designed primarily to prevent or minimize infection and its serious consequences The different mechanisms of production obviously indicate a different type of therapy Wounds in future wars will vary from those of World War II There will be fewer wounds from bullets and more from massive explosions In atomic warfare the incidence of burns will increase sharply as the two explosions set off in World War II indicated Probably in an

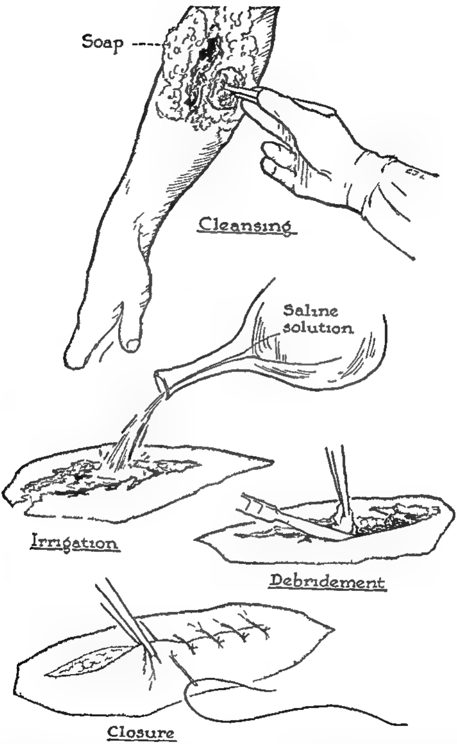

Fig 20 Steps in the treatment of a lacerated wound (Definitive care not first aid treatment) The cleansing process with soap and water should be confined to the skin surrounding the wound The wound itself is irrigated with sterile saline (0 9 per cent) solution gently using a sterile sponge to aid in cleansing the depth of the wound

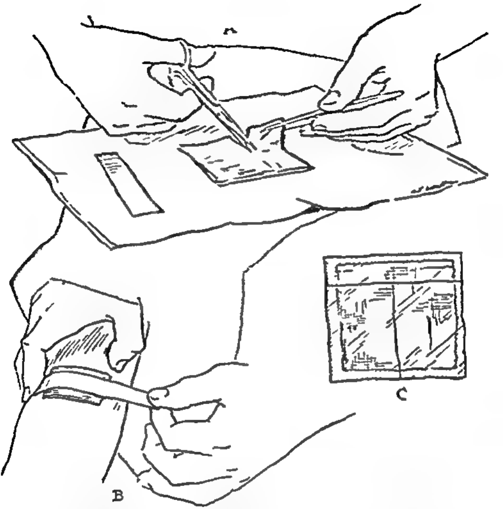

Fig 23 Application of a sterile dressing to a minor wound A a sterile piece of gauze is placed on a sterile or freshly ironed towel and the desired piece of gauze is cut off with sterile instruments B after the dressing is placed on the wound it is anchored with adhesive C sterile piece of gauze 2 to 3 inches in cased in cellophane wrapper available at most drug stores

atomic war the civilian casualties will be much greater than in all the military forces Therefore, first aid will be more important, largely because a greater delay will probably ensue between first aid and definitive care However this delay created by the tremendous number of casualties need not indicate a greater mortality rate than in World War II, because our chemotherapeutic agents are now much superior to those available in the last war

Obviously radiation injuries will be extremely frequent Their significance is not great from the standpoint of first aid because tissue damage is

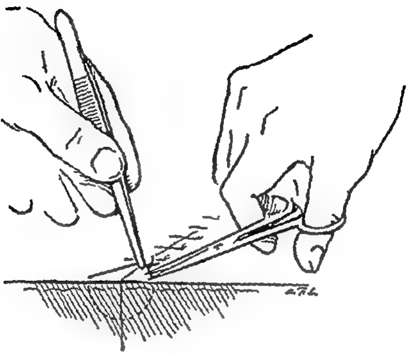

Fig 21 Removing sutures This is done by applying traction at one end and cutting the thread below the portion originally exposed on the surface so that contaminated thread will not be pulled through the tissues

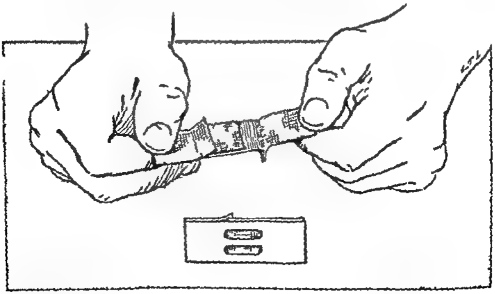

Fig 22 A type of sterile bandage with adhesive attached This is manufactured for commercial use and is obtainable at almost all drug stores Before application the protective layers are pulled off the adhesive as illustrated

booster dose of tetanus toxoid which then prevents tetanus very effectively Not a single death from tetanus among wounded military men followed the Pearl Harbor attack Although 15 cases of gas gangrene developed, all occurred in men whose wounds had been closed by sutures This fact and the knowledge that other infections are likewise *much* less frequent in war wounds which are packed open amply prove that war wounds (excepting those of the brain peritoneal and thoracic cavities) should be closed by suture only under unusual circumstances Utilizing the methods and principles just described made the mortality rate from infections following wounds much lower in World War II than in World War I Transportation *by airplane ambulance* to hospitals for active treatment contributed to this decrease The speed of modern warfare makes it impossible to maintain complete hospital facilities near the front Thus air transportation is very important particularly since early definitive treatment is so valuable

DRESSINGS

Dressings must be differentiated from bandages since a bandage represents the outside portion of the dressing and may be applied to contusions, abrasions etc without an actual dressing underneath it Only on rare occasions must the bandage be sterile, whereas on all occasions when a dressing is applied to an open wound the dressing must be sterile or as nearly so as possible Some of the *functions of a dressing* are similar to the functions of a bandage and may be listed as follows 1 In the presence of actual bleeding the most important function of a dressing naturally is *control of hemorrhage* Obviously light pressure will not control severe hemorrhage active pressure with the hand over the bandage must be used in such instances 2 Almost equally important in the function of a dressing is the *protection of the wound from contamination by bacteria* 3 Dressings *promote absorption of fluids* which consist chiefly of exudate containing bacteria and their toxins It is important that this exudate particularly if it develops into pus, not be allowed to accumulate in pockets in the wound Removal of purulent material facilitates healing 4 A dressing *increases the temperature about the wound* and of the tissues in the wound thereby increasing vascularity and the reparative processes 5 Dressings *aid in the application of medicinal agents* As previously intimated there are relatively few medicinal agents which may be applied directly into a wound Such substances as weak solutions of penicillin and zinc peroxide are relatively harmless to tissue cells, exert

Fig 24 Approximating wound edges without sutures When a wound is so shallow that sutures are not required the edges may be approximated with adhesive folding the midportion and sterilizing it over a flame before application A sterile dressing is then applied

not immediate On the other hand thermal burns in atomic warfare are extremely common (see also Chapter 10)

In the *first aid treatment* of war wounds control of hemorrhage and treatment of shock are paramount In combat, treatment of shock with intravenous plasma is now actually first aid therapy Blood is preferable to plasma in shock due to hemorrhage but is rarely available on the field

The *definitive care* of war wounds differs from that in civilian life in one major issue namely that war wounds are not closed However operative treatment including debridement of the wound is always indicated unless contraindicated by other more serious injuries The wound is packed open lightly with gauze placing a fine mesh gauze impregnated with petrolatum between it and the wound surface to prevent the gauze from sticking to the wound Penicillin and various other antibiotics are utilized extensively in the definitive care of the wounded for prophylactic as well as therapeutic measures against infection

The method of prevention of tetanus (lockjaw) differs in war since active immunity to tetanus is induced in all servicemen in the Armed Forces by injection of tetanus toxoid before they embark for the fighting front Instead of a dose of antitetanic serum the soldier or sailor gets a

booster dose of tetanus toxoid which then prevents tetanus very effectively Not a single death from tetanus among wounded military men followed the Pearl Harbor attack Although 15 cases of gas gangrene developed, all occurred in men whose wounds had been closed by sutures This fact and the knowledge that other infections are likewise *much* less frequent in war wounds which are packed open amply prove that war wounds (excepting those of the brain peritoneal and thoracic cavities) should be closed by suture only under unusual circumstances Utilizing the methods and principles just described made the mortality rate from infections following wounds much lower in World War II than in World War I Transportation *by airplane ambulance* to hospitals for active treatment contributed to this decrease The speed of modern warfare makes it impossible to maintain complete hospital facilities near the front. Thus air transportation is very important particularly since early definitive treatment is so valuable

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bactericidal action, and may be safely applied See Chapter 2 for detailed discussion of antiseptics

Dressings are applied directly over the wound and as intimated, are fixed in position either by a bandage (see Fig 18) or by adhesive (see Fig 23B) Unless fixation is thoroughly achieved the bandage tends to shift out of position and thereby permits contamination of the wound

In addition to the two methods of application and fixation of dressings as described in the preceding paragraph numerous modified procedures are available When dressings are applied to wounds over a joint where extension might put tension on the wound edges, the dressing is applied with the joint in position of flexion Figure 25 illustrates how a folded piece of sterile gauze may be placed over a wound in the flexor surface of the hand and the fingers clasped over it to obtain fixation in the optimum position

FOREIGN BODIES

Perhaps the most common foreign body with which the first aid attendant will be confronted is a *splinter* If the area about the splinter is exceedingly dirty, it should first be cleansed with a solvent such as ben

Fig 25 Dressing wounds in the palm of the hand When dressing these wounds sterile gauze may be folded and placed in the palm so that the fingers may be flexed against it, thereby eliminating tension on the wound edges Complete fixation may be obtained by the application of a bandage as shown in the insert

zene or gasoline followed by soap and water or alcohol, taking care not to break off the splinter A needle is then sterilized perhaps by heating it over the flame of a match, and the splinter is removed To prevent dirt being ground into the depths of the wound after removal of the splinter it is advisable to apply a small sterile dressing *Broken needles* constitute a fairly common type of foreign body and usually will be encountered in the feet or hands Obviously, if the broken end of the needle is visible outside the skin it may be removed If the patient felt the impact of a sharp object and the attendant can find a source of entry, the needle or foreign body should be searched for on the floor to ascertain whether or not it was broken and a part missing Naturally, if the needle is whole and found at the site of injury, the probability is that no foreign body is present in the wound On the contrary, if the needle is broken, the chances are that the broken end is in the tissues The presence of the broken end will appear more likely if pressure over the wound of entry produces significant pain Occasionally the fragment may actually be palpated However, palpation should be minimal since such pressure may drive the needle deeply into the tissues and actually encourage it to migrate Since operative removal will therefore be necessary, the patient should be immobilized until a physician s aid may be obtained If the wound of entry is on the foot he must not walk, since walking will produce migration of the foreign body and make removal much more difficult The physician will localize the needle with the x ray before removing it

Bullets are naturally much more common as foreign bodies in war than in civilian life Contrary to the information extended to the public by movies books etc , it is by no means always necessary to remove bullets In general only bullets lying in joints bone or similar vital tissues need be removed Naturally if an abscess develops several days after infliction of the wound the bullet would have to be removed before the infection will clear If an abscess does not develop within the few days following injury the bullet tends to become surrounded with fibrous tissue, isolating it to some extent from the adjacent tissues The ill effects of its presence are then limited practically to mechanical disurbance of function Obviously if a bullet is impacted against a tendon or in a tendon its movement will be seriously interfered with, and removal of the foreign body would be required Wounds inflicted by shotguns are naturally entirely different from those inflicted by a rifle A shotgun discharged at close range produces massive destruction of tissue and carries with it large quantities of clothing etc Such wounds require expert debridement (i e excision of devitalized tissue removal of foreign bodies

etc) Tetanus (lockjaw) and gas gangrene are very prone to develop following such wounds

Wounds inflicted by *knives* and *daggers* may or may not be associated with a foreign body Any foreign body present is usually the broken tip of the blade If the sharp tip is of any size its presence is apt to be detrimental migration is apt to take place, and during migration vital structures may be damaged There is, therefore a slightly greater indication for removal of the sharp ends of knife blades, etc, particularly if vital structures are adjacent

The *paper wadding burned powder,* and other foreign bodies embedded in a wound produced by a blank cartridge contribute to the seriousness of the wound because of the possible development of tetanus Although the skin about the wound of entry may be burned and discolored with burned powder, the actual wound of entry is usually small but may be multiple A surprisingly large amount of foreign body, including bits of clothing and burned powder, can be carried into the subcutaneous tissue through a relatively small wound This fact accounts for the high incidence of development of tetanus in such wounds unless antitetanic serum is given The presence of foreign bodies associated with the absence of oxygen favors the growth of tetanus bacteria which may have been carried in with the patient s clothing or with the paper wad

Foreign bodies in the eye are extremely frequent and are remarkably disabling while the foreign body is present Most foreign bodies which are not rapidly extracted spontaneously are under the upper lid The space under the upper lid is so extensive that the patient himself will rarely be able to extract the foreign body Naturally, solid sharp objects, such as pieces of cinders constitute most of the foreign bodies in the eye producing symptoms The attendant may remove the foreign body by clasping the lash between the thumb and first finger of one hand pulling gently and depressing the cartilaginous portion of the upper lid with a toothpick held in the other hand while the patient is being instructed to look down (see Fig 26) This everts the lid and allows the attendant to hold the lid in place with one hand while he removes the foreign body with the tip of a clean handkerchief held in the other hand The everted lid stays in place, in fact requires a little traction on the lash to return it to its original position Occasionally the foreign body is impacted in the cornea or sclera When this takes place it is preferable to refer the patient to a physician since removal in reality, requires training and skill Immediate removal is important because of the danger of development of an ulcer of the cornea at the site of the foreign body

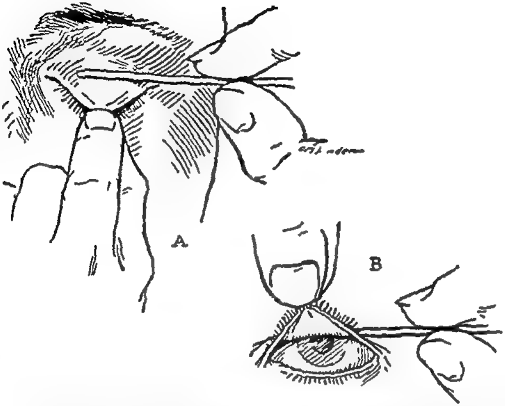

Fig 26 Method of removing foreign body from the eye A the lash is grasped between the thumb and index finger the upper lid depressed with a toothpick as the patient is instructed to look down B the lid is everted by pulling upward on the lash against the toothpick

Foreign bodies in the nose (i e nasal cavity) are usually encountered only in children who insert various types of foreign bodies, such as pebbles and corn, into their noses somewhat in an experimental way Symptoms would consist of blockage of the air passage and perhaps the discharge of bloody mucus Removal may be very difficult First the type of foreign body present and its location must be ascertained If it is still located near the exit it may be seen by shining a strong light into the nose and retracting the alae of the nose with some sort of makeshift instruments such as two bent hairpins If the foreign body is located near the exit a hook may be made by bending the end of a hairpin and inserting the hooked end behind the foreign body *without pushing it further back* and pulling it forward If the foreign body is far back or cannot be seen it is usually preferable to delay treatment until a physician s services may

be obtained lest the arduous efforts of the first aid attendant result in harm to the mucosa of the nose with consequent infection

Foreign bodies in the ear are likewise usually encountered in children and are the result of misdirected play Vision into the ear canal can be facilitated by pulling upward and outward on the upper lobe of the ear If a foreign body is visible and near the exit, the bent end of a hairpin (forming a hook) may possibly be inserted behind the object by gentle and skillful manipulation, the foreign body can then be extracted If preliminary attempts to remove it are unsuccessful, it is indeed preferable to seek a physician s assistance, since unskilled attempts to remove the foreign body may result in trauma and infection The application of one or two drops of a bland clean oil, such as mineral oil, is permissible and may allay the discomfort until a physician s services can be obtained

WOUNDS INFLICTED BY ANIMALS

Dog Bites Injuries inflicted by the bite of a dog are extremely common The most serious phase of a dog bite is the possibility of the development of rabies Fortunately relatively few of the dogs inflicting injury by bite have rabies, but the disease is prevalent throughout the entire country However the subject is extremely important since the disease in the human being is 100 per cent fatal Fortunately, it can be prevented by the injection of attenuated virus as originally devised by Pasteur

Perhaps the most important duty of the physician or first aid attendant is to try to ascertain whether or not the animal is rabid If the bite was inflicted by a pet dog which notoriously is cross and was being tormented there should be no need for administration of the attenuated virus On the other hand if a patient is bitten by a strange dog on the streets the chance of rabies becomes more prominent Characteristically the rabid dog, during the stage of development of the disease when he is in a biting mood has a desire to wander far and wide He proceeds at a running gait, biting at everyone near him and in fact goes out of his way to find his subject to satiate his desire for biting Attempts should be made to *find this animal* The police will cooperate in this problem When the animal is found he should be locked up and observed *but not killed* If the animal is rabid he will show unmistakable signs of the disease within 48 hours of inflicting the bite For safety s sake most animals are kept under observation for eight or ten days after the bite Administration of the attenuated virus at any time up to four to six days following the bite offers

protection in at least 95 per cent of cases Treatment must not be delayed beyond this time If the dog dies, the brain should be examined by the City or State Health Department to ascertain whether or not any Negri bodies are present The attenuated virus is administered usually in daily doses for 10 to 14 consecutive days and produces very few untoward symptoms

The immediate treatment of a dog bite in which rabies is not suspected is relatively simple and does not differ greatly from that already described Since there are relatively few pathogenic bacteria in the dog s mouth, compared for example with the human mouth, the chance of development of pyogenic infection is relatively trivial Most dog bites will be penetrative, with short areas of laceration not requiring suture If the laceration is long gentle irrigation of the wound, debridement, and suture are carried out as already described When the bite is inflicted on the face there will naturally be greater indication for suture of small lacerations in order to minimize the amount of scar The question of administration of antitetanic serum will be difficult to decide, and must of course be left to the judgment of a physician

If it seems possible that the animal inflicting the bite is rabid, the type of therapy for the wound is different than that just described Apparently the virus implanted in the bite by way of the dog s saliva is destroyed by strong oxidizing agents such as nitric acid and phenol although decisive proof of this *is not available* Therefore, after irrigation nitric acid or phenol may be swabbed into the wound as soon as possible, but is not strongly urged It is well known that not all patients sustaining bites from rabid dogs develop rabies even though prophylactic attenuated virus therapy has not been instituted

Cat Bites Bites inflicted by cats are more serious than those inflicted by dogs largely because the bacteria in the cat's mouth are more pathogenic to the human being In this respect the cat bite resembles the human bite in severity Another reason that the cat bite is prone to develop serious infection is because the bite is usually penetrating with little laceration thereby not allowing adequate drainage Little can be done in the first aid way except to wash the area surrounding the bite and apply sterile dressings Since infection is so prone to develop it is essential that the wounded part be immobilized very effectively to aid the body in combating the infection Chemotherapy is strongly indicated

Snake Bites Contrary to general opinion there are only four types of poisonous snakes in the United States, viz the rattlesnake (13 species), copperhead, cottonmouth moccasin and coral snake (The difference be-

tween a poisonous and nonpoisonous snake bite marking is shown in Figure 27) In reality, the seriousness of snake bite is greatly exaggerated, since not over 15 or 20 per cent of adults bitten by rattlesnakes would die even though they were untreated However, it should be emphasized that the size of the snake and the size of the person bitten largely determine

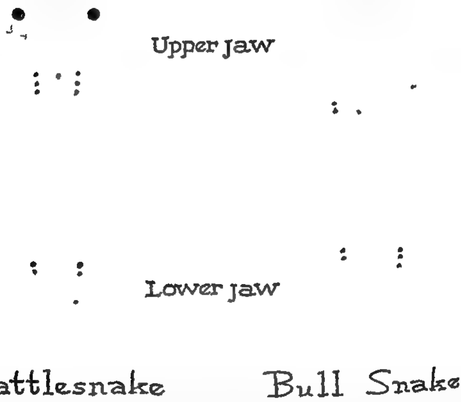

Fig 27 Bite marking made by poisonous snake compared with nonpoisonous snake (natural size for average size mature snake) On the left are the bite markings (upper and lower jaw) made by the fangs and teeth of the western diamondback rattlesnake The two large black dots represent the puncture wounds made by the fangs The stippled areas under the fang marks represent the areas where the venom is deposited under the skin because of the curvature of the fangs and their tendency to fold at the termination of the strike the deposit of venom will be slightly below the puncture wound made by the fangs This indicates that the cruciate incision made to evacuate venom should actually be centered over this deposit although cutting through the fang marks The parallel rows of dots below and medial to the fang marks are marks made by the teeth of the upper jaw They as well as the lower jaw teeth markings shown below may not be visible particularly if the strike was made through clothing On the right are upper and lower jaw markings made by the nonpoisonous bull snake Seldom will the entire pattern be visible (After Pope and Perkins Arch Surg 49 331 1944)

the seriousness of the bite In other words, a young child, 2 or 3 years old, bitten by a large rattlesnake would be confronted with at least a 50 per cent possibility of fatality if untreated The most poisonous snake is the cobra of India where the mortality rate in adults will be about 50 per cent

In snake bites much depends upon immediate first aid treatment and the type of treatment given A tourniquet should be applied immediately This tourniquet should be tight enough to block the lymphatics and venous flow, but *must not* block the arterial supply As soon as possible the site of the bite is washed thoroughly to remove venom on the skin about the fang mark, the skin is then prepared with iodine and alcohol, and a sharp knife or razor blade used to incise each fang mark in a cruciate (i e , in a crossed incision) fashion Experiments conducted by Jackson prove conclusively that proper incision and suction actually will remove venom if performed within a few hours following the bite Jackson has likewise shown that all the home remedies recommended for this accident are useless, many are harmful when applied to the incised area The tissue may be squeezed, attempting to evacuate some of the toxin Suction over the incised wound is efficient in removing venom It is best achieved with a rubber bulb as is contained in the snake bite packet obtainable at the drug store If this is not available suction by mouth may be instituted provided the attendant has no sore in his mouth The toxin is absorbed from raw surfaces but not from the intestine *Antivenin should be given immediately* 1 to 6 ampules depending on the size of the snake and condition of the patient

The tourniquet should be left on for hours releasing it for several seconds after each half hour thereby allowing only slow absorption of the toxin The patient is observed for serious symptoms such as weakness vertigo tachycardia, irregular or weak pulse, and marked swelling or discoloration at the site of the bite

A serious error in therapy is the administration of insufficient antivenin A small child requires proportionally larger doses (1 to 6 ampules) of antivenin than does an adult the total dose should be about the same for each Rest is very important The victim must conserve his energy and not be allowed to walk long distances or run in the excitement to obtain aid Another serious error made in snake bites is to administer alcohol in the form of liquor Alcohol is a rather pronounced medullary (vital centers of the brain) depressant Since part of the serious effect of snake toxin is depression alcohol is contraindicated For serious symptoms (e g , hemolysis of blood) transfusions are indicated

Insect and Arachnoid Bites The most common of the serious bites is that inflicted by the Black Widow spider This spider, which is relatively large, measuring 1 to 2 cm in diameter, is identified by the hourglass shaped red spot on its ventral surface However, very few bites inflicted by this spider, particularly in adults, are fatal This spider is widely distributed and is found in practically all parts of the United States The toxic condition created by the bite of the spider is called arachnoidism because of the fact that it belongs to the Arachnida class The most important features of the toxic effects produced are abdominal pain and diffuse muscle spasm of the abdominal muscles, thereby simulating conditions requiring immediate surgical care This abdominal condition may be differentiated from most other conditions requiring immediate operation because of the presence of only slight tenderness and usually because nausea and vomiting are absent Muscle spasm may be overcome by the use of concentrated solutions of calcium gluconate or of magnesium sulfate administered intravenously by a physician If the victim is a baby and the bite is detected soon after infliction, a tourniquet should be applied above the bite, and the area incised Suction may be applied if a cup or pump is available Antivenin should be given if available

The scorpions are feared by most people, but the bite is practically never fatal Much more serious are bee or hornet stings when the victim is stung by large numbers of the insects If this happens toxic effects develop rapidly are serious and even fatal Local application of ointments containing cooling drugs, such as menthol or thick paste made of water and sodium bicarbonate will relieve the symptoms to a great extent. Ice packs may be applied to the areas involved, producing vascular constriction thereby slowing up absorption of the toxins injected by the insects Injection of serum or blood obtained from a well immunized apiarist may be effective in neutralizing the toxins from numerous bee stings although bee antivenin is more desirable and effective if available (Beck)

Occasionally a person is sensitive to the poison of the insect or arachnoid bite and serious reactions including death may result Under such circumstances adrenalin and antihistamine compounds will be indicated as soon as they can be obtained and given

Chiggers Chiggers are very troublesome in certain localities particularly in the South They are red in color and barely visible to the eye They do not burrow into the skin but attach themselves to the integument Commonly they attack the skin at points of constriction i e a belt or garter Prophylactic treatment consisting of the application of 5 per cent sulfur in talc as a dusting powder is quite effective when applied before

exposure Numerous prescriptions have been recommended for treatment after the parasites have attached themselves A fairly effective solution in eliminating the itching and irritation is calamine lotion to which menthol and camphor have been added in sufficient quantities to make a 0 5 per cent solution of each Recently a new substance known as rotenone (2 per cent solution) has been recommended for elimination of the parasites

Human Bites Although human bites are relatively uncommon, they are extremely important because of the severity of infection which so frequently develops in the wound The tissue itself may be badly lacerated, the wound usually is a punctured one, thereby explaining in part the tendency for the development of severe infection The massive contamination produced by contact with the human mouth is the other important factor in the severity of the infection The bacteria most prominent in this type of infection are staphylococci, streptococci, fusiform bacilli, and spirochetes, the latter of which are anaerobic, i e, grow without oxygen Because of the tendency toward development of a serious infection, immediate treatment is important Immediate irrigation under running water is indicated A sterile dressing should be applied and the patient sent immediately to a doctor for definitive treatment If there is much laceration, debridement is strongly indicated, the wound *must not be closed* This procedure is advised by many surgeons, even though the wound is small and of the punctured type Large doses of penicillin intramuscularly or by mouth are advisable for a few days in an endeavor to keep the subsequent infection down to a minimum The wounded part should be put at rest particularly because of the tendency toward development of severe infection

CRUSH INJURIES

Various type of accidents may lead to crushing injuries Obviously if the chest and abdomen are crushed with some heavy object the patient may die before help arrives However, crushing injuries to the extremities are not immediately serious but become serious later because of *shock* and *kidney complications* Crushing injuries are naturally common during air raids when victims may be trapped beneath falling debris

When the patient is extricated from the fallen debris he may show surprisingly few manifestations of shock The blood pressure and pulse may be nearly normal and in fact there will usually be little or no swelling of the injured parts However within a few hours swelling of marked degree may develop This swelling is caused by the extravasation of

plasma or blood (or both) into the injured tissues This loss of fluid tends to produce shock which must be treated promptly as discussed later A day or so after the accident, there commonly develops a serious disease of the kidney which often results in death Blood, albumin and casts appear in the urine and the excretory mechanism is thereby interfered with

First aid treatment can be very helpful indeed if properly carried out Enough information is now available to prove that the shock is due to the loss of fluid into the injured tissue As has been shown by Patey and Robertson (Brit M J p 212, Aug 1942, Lancet, 1 780, 1941) immediate compression of the injured tissue by an elastic bandage will prevent the swelling and thereby minimize the shock An elastic web bandage is superior to other types Naturally care and experience are necessary in the application of the bandage Obviously, if it is too tight serious obstruction to the blood vessels may develop and actual gangrene be produced The amount of pressure under the bandage should be equal to 40 to 60 mm of mercury It should be applied from the distal part of the extremity proximally Pain may develop shortly after extrication of the victim, morphine or a similar drug will then be indicated The patient should have care equivalent to the prophylactic treatment of shock For example he should be subjected to complete immobility and not be allowed to get up or move about Obviously any open wound should receive care as has been described elsewhere Large doses of sodium citrate and bicarbonate (30 to 40 gm per day) are helpful in minimizing the serious effects on the kidney (Bywaters E G Brit M J p 643 Nov 28, 1942 Surgery Gynecology and Obstetrics 75 612, 1942) Experimental work of Duncan and Blalock (Ann Surg, 115 684 1942) reveals that the application of cold to the crushed extremity is helpful, but only if it is applied while the injury is being sustained Naturally, any consideration of local therapy before extrication from the fallen debris is out of the question It should be emphasized very strongly that *heat in no form should be applied to the injured extremity*

If the extremity is crushed so badly that the blood supply seems to have been destroyed, amputation may be necessary The patient should be observed closely during the convalescence since the development of gangrene usually demands early treatment in the form of excision of that portion of the extremity Obviously penicillin or some other antibiotic will be indicated if an open wound is sustained

6

Shock, Blood Transfusions

CHARLES B PUESTOW

SHOCK

One of the commonest conditions associated with severe injuries and other first aid problems is *shock* This is a rather general term and may be produced in a variety of ways and by several causes It may be defined as a *general depression of all functions of the body* and is based primarily upon a failure of function of the *peripheral vascular system,* in other words failure of function of the blood vessels throughout the body but not of the heart itself In order to understand this better, let us consider the mechanism of our circulatory system This may be divided into three main parts 1 the heart which pumps the blood, 2 the arteries capillaries and veins, which form a closed system of tubes through which the blood flows and 3 the blood itself The purpose of the circulatory system is to carry food (in the form of chemicals synthesized from products of digestion) and oxygen to the body tissues and waste products from them In order to have the blood circulate normally and give off its oxygen and food to the tissues, it must flow through the arteries under a certain degree of pressure called blood pressure Thus blood pressure may be defined as the pressure exerted by the blood against the surrounding wall of the blood vessels In the arteries the maximum blood pressure normally is equal to the pressure exerted by a column of mercury 100 millimeters or more in height It is dependent upon the pumping power of the heart the muscle tone and elasticity of the walls of the vessels and an adequate amount of blood to fill the system A failure of any of the three may prove very serious When the pump is unable to do its work a patient will show evidence of heart failure When there is severe hemorrhage, the loss of blood may deplete the blood volume in the vascular system enough to jeopardize the life of the patient When there is a disturbance of the size or tone of the vessels themselves shock may result That is why shock sometimes is called peripheral circulatory failure Its exact mech-

anism is not fully understood Years ago it was thought that an enlargement or dilatation of the peripheral vessels occurred to such an extent that there was an insufficient supply of blood to fill the system and maintain an adequate blood pressure During recent years evidence is accumulating to the effect that there is actually a vasoconstriction (that is, a narrowing of the blood vessels) which is associated with an increased permeability (ability of fluids to pass through) of the vessel walls so that an abnormally large amount of fluid escapes The heart then attempts to compensate for the deficiency by beating *faster* but *is seriously* handicapped by the decreased blood volume The result of such disturbances is an inadequate circulation

Shock accompanies a large percentage of accidents, often very trivial ones Where shock is due to the accident itself, we speak of it as *traumatic shock* *Severe burns* are one form of injury frequently complicated by shock This is the result of the large amount of fluid lost into the burned area and underlying soft tissues and from the "weeping" of the burned surface Sometimes the mere sight of a wound or of blood will cause a patient to go into shock This is called nervous or psychic shock, and is similar or identical to fainting, which will be discussed later Shock sometimes accompanies sudden severe abdominal disturbances such as ruptured ulcers as well as conditions producing severe *pain* as seen in *colics due to gallstones or kidney stones, but this is of a different type* from true traumatic shock Pain associated with injuries increases shock Under such circumstances, shock is due most likely to a nervous disturbance Certain toxins or foreign proteins can produce *anaphylactic shock* An overdose of insulin will produce shock

Symptomatology Subjective symptoms complained of by patients in early acute shock consist of a feeling of *marked weakness, faintness* sometimes dizziness and often nausea The patient's general appearance is quite typical and of great diagnostic value The skin is first pale and then becomes an ashen color It is cold and becomes clammy from perspiration The pupils are dilated and the eyes have a glassy or vacant stare

Because of inadequate circulation to the brain there are definite changes in the mental state As the state of shock progresses or continues, greater stimuli are necessary to produce any response from the patient Finally a stupor may set in

The unsuccessful efforts of the heart to improve the circulation by increasing its rate results in a rapid but weak pulse The rate may be accelerated from a normal of 70 to 80 beats per minute to as much as 160, but the volume or quality becomes so diminished that it may become

thready or even imperceptible at the wrist The heart sounds are faint and distant, and respirations become shallow and rapid There is a so-called critical pressure which varies in different individuals but which is in the neighborhood of 50 millimeters of mercury If a patient s blood pressure remains below this critical level for a number of hours, the resulting lack of oxygen to the brain and other body tissues may produce irreparable damage, after which no form of treatment can save the patient s life The blood pressure gradually drops and may reach a level so low as to be difficult to determine, although the heart is, of course still beating

When shock is due to *hemorrhage* the symptoms are very similar to those just described The peripheral vessels contract in an effort to diminish the capacity of the vascular system and thus to compensate for the loss of blood As a result the initial symptoms may consist of a pallor of the skin lips, fingernails and lining of the eyelids with little change in pulse rate or blood pressure Because the circulation to the brain at this stage remains adequate, the patient is alert and usually is apprehensive If bleeding continues, in time the peripheral blood vessels no longer will be able to reduce their capacity to that of the remaining volume of blood Then the pulse rate increases and the blood pressure falls The respirations in severe hemorrhage become deep or gasping in nature (air hunger) rather than shallow, as in shock due to other causes, and the patient remains excited and apprehensive for some time

It should be emphasized that *hemorrhage alone will produce shock if the blood loss is sufficient* The amount of bleeding which is likely to produce shock varies in different individuals but is usually between one and two quarts However this does not have to be external bleeding from the surface of the body but may be bleeding into any of the body cavities or into the body tissues themselves Thus a person can bleed to death with no external evidence of blood loss

Diagnosis It is important for a person administering first aid not only to be able to recognize shock or impending shock but to be able to differentiate it from other conditions which might be confused with shock Such conditions might need entirely different or even opposite first aid and subsequent treatment *Acute heart failure* is one of these conditions Here it is not the peripheral circulation but the heart itself which is at fault The most prominent signs of acute heart failure as will be discussed in detail later are those of congestion (an engorgement of the veins and capillaries with blood) The skin is cyanotic or bluish in color rather than pale or ashen The veins stand out prominently Fluid may collect under

the skin (edema) and pressure with a finger will leave an indentation (pitting), especially in the dependent parts of the body The pulse is likely to be irregular Congestion in the lungs results in fluid in the air passages, and rhonchi (moist rattles) can be heard when the patient breathes

If you are called to administer first aid to an injured person, try to obtain quickly some history as to the nature and cause of the accident If the patient is conscious, speak to him in a quiet and reassuring manner and obtain from his answers not only the information you desire but an evaluation of his mental reactions *Observe him carefully* Note the color of his skin and mucous membranes Feel his hands and face both for temperature and moisture Look at the eyes for their color and motion Examine the pupils—they generally are dilated in shock If they are con tracted down to a pinpoint size, the patient may be under the influence of some opiate Watch and listen to his breathing See if his arms are rigid or totally relaxed Examine him for superficial wounds Look over his head and chest for external evidence of injury Gently feel his abdomen for tenderness or rigidity Make these observations carefully and quickly, disturbing and exposing the patient as little as possible

Treatment Shock is a serious condition Prolonged deep shock may produce such extensive damage that subsequent treatment cannot save the patient s life First aid treatment should have for its purpose the *prevention of shock* as well as the treatment of it The same principles of treatment are carried out in avoiding shock that are used in overcoming it In most instances when shock complicates an injury, it must be over come before the injury itself is treated unless active hemorrhage is present Hemorrhage should always demand first consideration Methods of con trolling bleeding are discussed in Chapter 7

Remember that extensive hemorrhage can occur into the tissues especially where fractures of the long bones exist Such hemorrhage can be sufficiently severe to be fatal Large quantities of blood and serum frequently are lost from the circulation into the muscles and other soft tissues in fractures of the pelvis or femur (thigh bone) Moving a fractured extremity about may cause the jagged ends of bones to increase this bleeding and thus increase shock Therefore fractured extremities should be kept at rest This is best accomplished by proper splinting which is discussed in Chapter 11

After control of hemorrhage other measures are instituted If the patient is exposed to low temperature application of heat may be in dicated However, heat should be restored *gradually and only mildly*

since if applied too intensely it might cause vasodilation and increase shock Nevertheless, since heat loss is serious, and may be rapid, every effort should be made to keep the patient s body warm Cold and wet clothing should be removed but the patient should not be exposed unnecessarily Warm blankets, coats or other garments should be placed *both under and over* the patient A dozen warm blankets on top of a patient will not prevent the loss of body heat if he is lying on the cold ground and is not protected from below Newspapers between blankets will help prevent the dissemination of heat In placing blankets under the patient lift him very gently so as to disturb him as little as possible The application of external heat in the form of hot water bottles or other heated objects is not recommended Recent studies have shown quite conclusively that shock may be deepened or prolonged by raising the surface temperature too rapidly by external heat However, if the application of such heated objects seems indicated, great care must be exercised to avoid burns Because of poor peripheral circulation, a patient in shock will sustain burns more readily than a person with normal circulation Hot drinks may be given if the patient is *able to swallow* and does not have evidence of injury to his abdominal organs Any hot liquids such as coffee tea water, broth or milk can be given *Do not try to pour liquids down the throat of an unconscious patient* Drowning or aspiration pneumonia may result Patients who are likely to need a *general anesthetic for an emergency surgical procedure should not be given anything by mouth* Next to the control of hemorrhage the *maintenance of body heat* is the most important measure in controlling shock

The *position of the patient* also is very important When the blood supply to the heart and brain has been markedly diminished for a long period of time permanent and often fatal damage is done and cannot be remedied To improve the circulation to the head and chest when a patient is in shock the body and lower extremities should be elevated 12 to 18 inches above the head this may be difficult to accomplish unless the patient is in a bed or on a cot Under no circumstances permit the patient to sit or stand

Pain increases shock and should be relieved as much as possible The splinting or immobilization of injured parts frequently will reduce pain Where pain is severe and no contraindications exist a hypodermic injection of morphine should be given Opiates are contraindicated however in cases of severe head injury and where abdominal trauma exists and the administration of an opiate might mask the development of symptoms

The administration of *stimulants* to patients in shock is of very little value Coffee and tea are of more value for the heat and fluid which they give than for their stimulating action The injection of stimulating drugs probably does no good and time should not be wasted in preparing and administering them

When the condition of the patient will permit, he should be trans ported to a hospital or a bed particularly if he is exposed to cold dampness, or other unfavorable conditions He should be placed in a warm room and all drafts avoided However, movement of the patient should be done with the least possible disturbance to him Methods of trans portation will be discussed in Chapter 9

FLUIDS In our previous discussion of the cause of shock, we spoke of it as peripheral circulatory failure and stated that it was due to an inadequate quantity of blood to fill and maintain an adequate pressure within the blood vessel system This is due largely to a loss of the volume of blood It would, therefore seem logical that the best way to treat shock or to prevent it would be to increase the volume of blood by the addition of suitable fluids It is well known that injured persons who are given fluids to drink and are able to ingest them are less likely to go into shock than those people who are depleted in fluids and receive none For this reason it is well to give patients fairly large amounts of fluids *by mouth* to prevent or treat shock if none of the contraindications exist which we have mentioned previously These contraindications are unconsciousness severe head injuries and the likelihood of an immediate operation Fluids also may be administered *by bowel* where a certain amount of absorption will occur Weak *glucose* solution (3 to 5 per cent) or *physiologic salt solution* (0 9 per cent sodium chloride—this is approximately the same concentration of salt as exists in the normal blood) can be given *into the subcutaneous tissues* through needles which are passed through the skin where there is loose tissue which can be distended with fluids and give a fairly large area of absorption These areas are under or lateral to the breasts at the sides of the abdomen and sometimes in the thigh The solutions must be sterile and must be in sterile containers to prevent in fection of the subcutaneous tissues These methods however generally do not permit a rapid enough absorption into the circulation to combat shock quickly For this reason fluids are administered *directly into the vascular system* through a superficial vein Physiologic saline solution or glucose solutions of various concentrations are readily available in most hospitals and can be given with little danger They may be of consider able value in shock if marked dehydration exists that is when large

amounts of body fluids have been lost When there has been prolonged vomiting or diarrhea, such fluids will be of great value In the case of *massive hemorrhage*, glucose and salt solutions will give *temporary* improvement by helping to replace the blood volume, but this improvement will last for not more than an hour because the solutions are soon lost from the vascular system When shock is based on a disturbance of the permeability of the blood vessel walls which permits a more rapid loss of fluids through them, the administration of glucose and salt will merely mean a more rapid loss of fluids through the vessel wall The main advantage of the administration of such fluids is the introduction of food in the form of glucose (or sugar) and stimulation of the kidneys to eliminate waste products Occasionally, harm results from the administration of large amounts of salt and glucose solutions because the blood proteins which are very essential to the body are diluted and will pass through the vessel walls more rapidly, thus diminishing the amount in the circulating blood

Efforts have been made to find other fluids which will not pass readily through the blood vessel wall and which can be safely used to increase blood volume by injecting them directly into the blood stream Among *plasma expanders* which have been obtained from artificial substances are dextran, oxypolygelatin and polyvinylpyrrolidone (PVP) Dextran has been most extensively used in this country and is available in the emergency rooms of most hospitals These artificial substances remain in the circulation for comparatively long periods of time and exert their expansion effect upon blood plasma for as long or longer than does the administration of blood plasma itself They produce very little toxic effect but may produce abnormal bleeding when given in large quantities

Solutions of gelatin produce expansion of about equal duration to that of plasma or albumin They do not produce pyrogenic reaction and are cleared fairly rapidly from the circulation being excreted in the urine usually within 24 hours The use of artificial plasma expanders avoids the danger of serum hepatitis which accompanies the use of whole blood When only 500 to 1 000 ml of fluid replacement is indicated, expanders are very satisfactory When larger amounts of replacement are necessary, whole blood or plasma generally is indicated

Observations have shown that of the numerous solutions utilized in the treatment of shock *blood (500 to 2 000 ml by vein) is the most effective and valuable* There are two major components of blood 1, red blood cells and 2 plasma (serum plus fibrinogen) Of these two components, plasma is the more important in the treatment of shock, partic-

ularly when the shock has developed in the absence of loss of red blood cells When the shock is produced primarily by hemorrhage whole blood (that is, red blood cells and plasma) is desirable, although plasma alone is very effective Fibrinogen is that portion of the blood which forms the clot when the blood escapes from the vascular system To understand clearly the principles of transfusions and blood grouping the terms plasma and serum should be defined and differentiated Serum is the liquid part of the blood remaining after the fibrinogen has been allowed to clot and is removed Plasma contains serum and fibrinogen, the latter of which is prevented from clotting by the addition of an anticoagulant (for example, sodium citrate) to the blood, just as it is withdrawn Except for a few simple procedures, the definitive treatment of shock being complicated, *is carried out by the physician, not the first aid worker*

BLOOD TRANSFUSIONS

As the loss of blood volume is the most prominent feature of shock, the administration of blood transfusions should be the most logical treatment In recent years the use of blood transfusion has changed from a procedure employed only rarely and in cases of grave emergencies to one of our commonest and most beneficial methods of reducing the danger of accidents and operations

However, the administration of blood transfusions is not without dangers One of the most serious of these is the transmission of serum hepatitis to the patient Recent studies have shown that when only one pint of blood was administered over 1 per cent of the recipients developed serum hepatitis and when two pints were administered nearly 3 per cent developed this disease Thus if it is apparent that the blood loss is no greater than 1 000 ml it is safer to administer blood expanders such as dextran in an effort to overcome or prevent shock and to withhold blood until further observation indicates its definite need

Cross Matching of Blood Before discussing the methods of administering blood to patients we should mention the selection of proper blood for a patient Blood cannot be given indiscriminately from one person to another because the blood of the donor and recipient may be of different types when this situation exists the bloods are spoken of as being incompatible If they are mixed the red blood cells will clump and often will be destroyed This is spoken of as agglutination If a patient is given blood the cells of which will be agglutinated by his own blood serum, he will undergo a severe reaction manifested by chills and high fever which

sometimes is followed by death To avoid these reactions it is necessary to select the proper kind of blood The Landsteiner classification divides human blood into four main types or groups The following table lists these classified types and the percentage of the population having each type of blood

Landsteiner	Percentage
AB	7%
A	40%
B	10%
O	43%

Group O is called a universal donor because there is no agglutinating factor within the red blood cells Conversely, group AB is a universal recipient because there is nothing in the serum of this type of blood to cause agglutination, but the red cells contain both types of agglutinating factors The clumping of cells depends upon the interaction of the agglutinating factor in the cell and a corresponding specific substance in a serum The patient should receive blood of a type similar to his own This decreases the possibility of reactions from either the donor s cells (major) or the patient s cells (minor) being agglutinated Type O blood may be given to patients with any type of blood in emergencies as major side agglutination does not often occur here

It is also very important to determine the Rh factor of the blood Wherever possible a patient whose Rh factor is negative should be given blood with a negative Rh factor If such a patient receives Rh positive blood he may develop a permanent sensitivity and subsequent transfusions of Rh positive blood may produce a serious transfusion reaction

Blood typing is done by mixing a small drop of diluted blood with a drop each of types A and B sera separately After a short time these are examined under the microscope for clumping The A serum agglutinates type B blood while the B serum agglutinates type A blood If no agglutination occurs with either serum the patient is type O With type AB blood agglutination occurs with both sera The types of both patient and donor must be determined and the donor s type preferably should correspond to the patient s but a type O donor may be used However as reactions sometimes occur when the donor s type is the same as that of the patient a cross matching test should be carried out before any transfusion is given This is done by separating the cells and sera of both donor and patient s blood The patient s cells are mixed with the donor s serum, and the

donor s cells are mixed with the patient s serum If no clumping occurs within 30 minutes the blood types are considered compatible and trans fusion can be given with safety Besides making sure that the blood will not produce a reaction in the patient, one must also test the donor s blood for the possibility of syphilis Only under extreme emergencies should blood which has not been tested for syphilis by a Kahn or Wassermann test be given to a patient Blood should not be used from a donor who gives a history of hepatitis or jaundice

Methods of Administration One of the great difficulties of transfusion has been the prevention of clotting of the blood when it is outside of the body being transferred from the donor to the patient Two main principles have been followed in the transfer of fresh blood to prevent it from clot ting The first is spoken of as the direct method and does not have an anticoagulant added to the blood The second called the indirect method prevents clotting by the addition of an anticoagulant Because the addi tion of such substances was formerly thought to diminish the value of the blood, many methods and apparatus were devised to transfer blood in an unmodified form One is called the multiple syringe method Here both the donor and patient are placed side by side in the operating room and a needle or canula inserted into a vein of each A large number of 20 ml syringes are available to the surgeon who draws a syringeful of blood from the donor quickly administers it to the patient, then picks up a fresh syringe and repeats the process After each use a nurse washes the syringe to prevent clotting of the remaining blood and returns it to the surgeon A number of devices have been invented for drawing blood from the donor and injecting it into the patient through a closed system of tubes The principle of these consists of a three-way valve one valve leading by a rubber tube and needle to the patient s vein, one leading to the donor s vein and one leading to a basin of physiologic salt solution Con nected to the three way valve is a glass syringe The valve to the donor s vein is opened and the plunger of the syringe withdrawn thus filling the syringe with donor s blood The valve is then changed so that the syringe is in connection with the patient s vein and the blood is injected into the patient This process is repeated until the desired amount of blood has been transferred At frequent intervals the valve to the basin of physio logic salt solution is opened and the syringe washed out These methods work satisfactorily but are somewhat cumbersome and the apparatus often becomes blocked with blood clots Accordingly these methods have been abandoned in favor of the procedure utilizing the addition of anti coagulants as described below

It now has been quite well established that the addition of anticoagulants to the blood does not alter its value in any way and does not interfere with the ability of the blood to coagulate after it has been given to the patient For this reason, and because of its ease of execution, administration of blood containing an anticoagulant is commonly accepted as the best method of blood transfusion The National Institute of Health recommends approximately 125 ml of ACD solution B as anticoagulant for 475 ml of blood This ACD solution B contains trisodium citrate 13 2 gm , citric acid 4 8 gm , dextrose 14 7 gm , and water 1,000 ml The container of blood then can be brought to the patient s room and administered This method has many advantages The patient does not have to be transported to the operating room The blood can be given at varying rates of speed Any quantity can be given and the balance stored until some future time

Until recent years, blood was administered to the patient immediately after it was drawn from the donor However investigation has shown that blood may be preserved for a number of days and then administered with little loss in value and with no increased danger This has greatly augmented the convenience and ease of blood transfusion Blood can be kept available at all times in so-called *blood banks* where sterile conditions and a proper temperature maintain it in good condition Having been typed, the Wassermann reaction determined, and a bilirubin test made it is available for almost immediate use If a patient is in shock, his blood can be quickly matched with blood from the bank and the blood transfusion can be started in a very short time Many lives can be saved because of the ready availability of banked blood There are a few disadvantages to banked blood If it is stored for more than five to eight days there is likely to be some destruction of the red blood cells, use of old blood likewise may produce reactions Blood contains a substance called prothrombin which is important in clotting The amount of prothrombin in the blood diminishes when it is stored for a short time For these reasons fresh blood is preferable to banked blood

Blood Plasma Blood plasma consists of blood with red blood cells removed but containing fibrinogen as previously described It is obtained by centrifuging blood to which an anticoagulant such as sodium citrate has been added The cells being heavier collect at the bottom The volume of plasma recovered is equal to approximately 50 per cent of the volume of the whole blood used In certain types of shock plasma is of more value than whole blood When there has been a loss of fluid (plasma) from the blood but the red blood cells have not escaped, as sometimes

donor s cells are mixed with the patient's serum If no clumping occurs within 30 minutes the blood types are considered compatible and transfusion can be given with safety Besides making sure that the blood will not produce a reaction in the patient, one must also test the donor's blood for the possibility of syphilis Only under extreme emergencies should blood which has not been tested for syphilis by a Kahn or Wassermann test be given to a patient Blood should not be used from a donor who gives a history of hepatitis or jaundice

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shock is overcome and no further loss of plasma (from the surface of the burn or into tissues beneath) is taking place

Plasma has a few advantages over whole blood When pooled and of low agglutination titer, it can be given to patients of any type, therefore, typing and cross matching are unnecessary Plasma from many donors can be mixed and stored in any quantity desired If properly collected and prepared, it can be stored for long periods of time without deterioration In former years and especially during World War II, plasma was preserved in a frozen or dried form Unfortunately, this method of preservation does not destroy the virus producing serum hepatitis and many serious cases resulted It has now been established that the transmission of serum hepatitis in pooled plasma can be eliminated if the plasma is stored in liquid form for six months at from 86° to 90° Fahrenheit Under these conditions the virus of hepatitis is destroyed

Serum albumin is one of the important proteins found in human blood This with other proteins maintains osmotic pressure, which is important in preventing the loss of fluid from the vascular system and thus protects against the development of shock Human crystallin albumin has been isolated (Cohn) and is available for use It is put up in 25 gram ampules which can be diluted with 500 ml of water to make a solution comparable in value to an equal amount of plasma however, it may be given in a much more concentrated form Its advantages over plasma are its smaller bulk low salt content bacterial sterility, and inability to produce hepatitis Human albumin has the disadvantage of not containing globulin especially its gamma fraction which carries antibodies As these are present in human plasma this substance is preferable to human albumin Another disadvantage of human albumin is its great cost

The advance in the transfusion of blood in recent years particularly in the development of blood banks and the satisfactory preparation and preservation of blood plasma, has done much to furnish us with a readily acceptable agent extremely effective in combating shock

ELECTRIC SHOCK

The widespread use of electricity throughout the country and the extensive network of electrically charged wires everywhere have resulted in frequent injuries due to electric currents Too often these are the result of carelessness but some are unavoidable These accidents usually occur when medical aid is not readily available and when *first aid often must be*

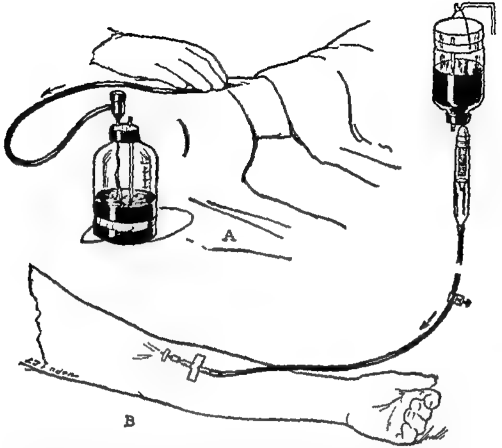


Fig 28 Blood transfusion A method of collecting blood for transfusion using a bottle with a vacuum in it B, administration of blood to the recipient The bottle must be elevated 3 or 4 feet to obtain proper flow of blood

occurs for example in burns there will be an increased concentration of cells in the blood This makes it thicker in consistency and impairs its circulation, especially through capillaries The red blood cell count, which normally is 4 500 000 to 5 000 000 cells per cubic millimeter of blood may have increased to 6 000 000 Under these circumstances, it is not advisable to add more blood cells to the circulating blood It is important, however to lessen the viscosity of the blood and to add to its volume When this is desired, plasma is an ideal agent Large amounts of plasma often are needed administration should be repeated when indicated This is true especially in severe burns It is estimated that a person suffering from burns should receive 1 000 ml of plasma daily for each 10 per cent of the body surface involved This must be repeated until all evidence of

quiet and examine him gently for other injuries which may need first aid attention Remember that he may go into *secondary shock* several hours after apparent recovery, especially if he is permitted to get up and exert himself, and that this may prove fatal Do not feel free to leave him alone until he is under adequate medical supervision, preferably in a hospital

administered quickly to save the victim Many factors influence the severity of electric injuries The voltage and amperage of the current are important, but death can follow contact with low voltage as well as with high tension wires Moisture from perspiration will increase the severity of injury whereas partial insulation by clothing will diminish it The part of the body through which the electric current passes affects the result If one leg contacts a wire while the other is on the ground and thus the current passes from one leg to the other, the danger of severe shock is less than if the current passes through the body Often, falls, as from poles, will follow electric shock and may produce additional severe injury

In rendering immediate treatment to a person who has received an electric shock and usually is unconscious the rescuer must remove the victim from contact with the current *at once without endangering himself* This may be done by throwing a switch if one is handy or by cutting the wire with an axe having a wooden handle to protect the user If he does cut the wire he should turn his head away so that the flash does not injure his eyes The injured person may be separated from the live wire by the use of a *dry* stick, rope, or leather belt

When the victim is freed he may be mentally confused or unconscious If he is breathing regularly and his pulse can be felt, it is most important to *keep him lying down quietly* Loosen the clothing about his neck so that he can breathe freely and then leave him alone He must be kept at rest where he is, and carefully watched Patients with electric injuries may attempt to get up and run when they regain consciousness this should be prevented as it may be followed by death due to heart failure After the victim has been at rest with normal respirations for an hour or more he should be moved to a hospital preferably by ambulance or litter

Severe electric shock may paralyze the respiratory center in the brain causing a cessation of breathing or it may cause ventricular fibrillation, a form of irregularity of the heart which usually is fatal If the patient is not breathing, artificial respiration by one of the methods described in Chapter 13 should be started at once Even though the victim appears to be dead and his pulse cannot be felt *artificial respiration must be continued for hours if necessary* Many electric shock victims who seemed to be dead have been revived after several hours of artificial respiration It is well to get help if possible and alternately administer artificial respiration as it is very strenuous and fatiguing There are several satisfactory machines on the market for giving artificial respiration Stimulants or opiates generally are contraindicated

When the victim has been revived and is breathing regularly keep him

bleeding part may be elevated if the wound is in the arm or leg If the wound is in the head or neck, raising the head and chest may slightly decrease the bleeding but is not advisable as it may decrease circulation to the brain and thus cause the symptoms of dizziness, faintness, stupor, nausea, and finally loss of consciousness

TYPES OF BLEEDING

Capillary Oozing A small, slow oozing from a superficial injury does not call for any drastic measures If hemorrhage is primarily from capillaries or very small veins, the blood will ooze steadily and will be dark red in color The rate of flow generally will not be rapid It can be controlled satisfactorily by applying pressure directly over the wound To secure the most efficient pressure and to minimize the danger of infection, a sterile or clean pad should be placed over the wound and pressure maintained by a tight bandage or one s finger or hand If sterile dressings are not available a clean folded handkerchief or a folded piece of a clean garment will serve the purpose Because of the danger of introducing infection one should not place his fingers or thumb directly in the wound if this can be avoided Be sure to remove any constricting garments, such as garters or tight sleeves which are present between the wound and heart as they tend to increase bleeding In the exceptional case of the individual whose blood clotting is at fault, as exists in hereditary types of bleeders, patients with liver damage vitamin deficiency or a low platelet count the oozing may continue and may require one of the other measures to be described The rate of bleeding however is slow and alarming symptoms usually will not occur

Venous Bleeding In case of *bleeding from veins* the blood flows in a *steady stream* under a *low pressure* The color of the *blood is dark red* Often the simple elevation of the bleeding part will control the bleeding, usually a gauze compress placed over the wound and bandaged snugly will suffice Firm pressure may be applied by the palm of the hand until a clot forms If bleeding continues pressure may be exerted at the lower edge of the wound on the side away from the heart Should this measure still fail to stop bleeding pressure will have to be applied either by hand or by tourniquet between the wound and the heart, as will be emphasized later in this chapter in the control of arterial bleeding

Arterial Bleeding *Bleeding from an artery* comes in spurts or jets except when it comes from such a depth that it wells up from the bottom of the wound and may appear to come in a steady stream It comes very

7

Injuries to Large Blood Vessels

GÉZA DE TAKATS

When injury results in sudden profuse bleeding immediate control of the bleeding is imperative The adult body contains approximately five quarts of blood Amounts up to one pint can be lost without any harmful effect, this is the usual quantity given by donors for the purpose of transfusion A sudden loss of one quart or more, however, produces symptoms of pallor rapid pulse and respiration, restlessness, dizziness and nausea Later, the victim may go into shock (peripheral circulatory failure), which has been discussed in Chapter 6, and finally lose consciousness The loss of a quarter of the total blood volume is dangerous whereas the loss of one half is usually fatal

For these reasons the urgent duty of the individual administering first aid is to stop hemorrhage temporarily until permanent control may be undertaken by the surgeon Four methods are available for this purpose namely 1 pressure bandage over the wound, 2, finger pressure in the wound 3, direct pressure on main arteries exerted by the fingers or hand and 4 pressure by means of a tourniquet (any material which enhanced by twisting exerts pressure around a limb)

Bleeding may occur through the broken skin at which time the patient may faint, not so much from blood loss as from the sight or smell of blood Or bleeding may occur in the tissues, at which time the affected part swells arrests bleeding but also stops circulation by compressing the artery

GENERAL MEASURES IN CASE OF BLEEDING

The injured must be placed in a horizontal position fainting from the sight of blood or from the actual loss of blood will occur readily if the patient is seated instead of being made to lie down The bleeding wound is to be exposed immediately all clothing covering it being removed The

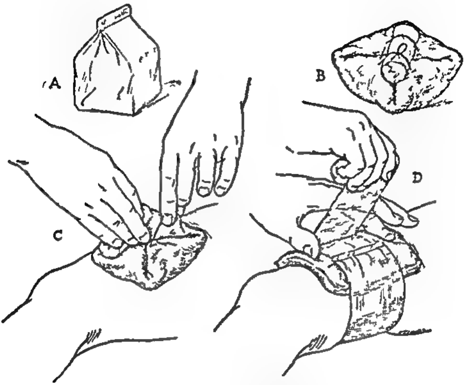


Fig 29 A type of compress dressing (Gallagher) particularly useful in controlling hemorrhage The bandage is packed and sterilized in a package as shown in A It consists of a square shaped pad containing grade A cotton waste which is resilient and supplies effective pressure before packing the pad is folded at the corners and an elastic bandage (e g stockinette cut obliquely) attached as shown in B If the wound is large and deep compression may be achieved best by inserting the pack still folded as in B otherwise the corners are released C and the bandage applied as in D This dressing appears particularly adaptable for use on bombers or for any deep wounds where hemorrhage is profuse and definitive treatment is not immediately available

dressing against the wound with the hand for two or three minutes to see whether or not the bleeding is controlled by local pressure Moreover, pressure can be applied more effectively with the hand than by a bandage After it is obvious that pressure is controlling the hemorrhage a bandage can then be applied It should be applied snugly and in fact should be reinforced with adhesive to maintain pressure since a bandage tends to stretch particularly if there is any motion of the part While waiting for transportation to a hospital any motion of the injured part should be prohibited by a sling confinement of the patient to a horizontal position etc , since activity increases the circulation and therefore would increase

fast The color of the blood is bright red, although it may be mixed with venous blood when both artery and vein are injured Such a finding calls for immediate quick action Delay or fumbling in such a case may cost the injured s life On the other hand, an overanxious attendant may mis judge the situation and institute measures which are unnecessary

For a rough estimate of the severity and rate of blood loss, the follow ing points should be kept in mind

1 When *blood drips slowly from the wound* bleeding is not likely to be serious and the bleeding will readily stop on mild pressure

2 When *blood flows in a small steady stream* or comes in small spurts loss of blood deserves concern but not alarm It may still stop on pressure exerted over the bleeding area by a snug padded bandage, should this fail direct pressure over pressure points to be described should be em ployed (see Fig 31) Occasionally, after pressure has been applied over an artery for a short period of time bleeding from the wound will be greatly diminished and can be controlled by a pressure dressing directly over the wound However if a large artery has been severed it may be necessary to supplant arterial pressure by the use of a tourniquet

3 When *blood flows in a large stream* or *spurts in large quantities* the situation is very serious and must be dealt with by direct pressure or tourniquet

METHODS OF CONTROLLING HEMORRHAGE

There are four major methods available for the control of hemorrhage One may be used to augment the other but in general the severity of the hemorrhage determines which method should be adopted

1 **Application of a Pressure Dressing to the Wound** When bleeding is relatively mild the *application of a sterile dressing* held against the wound with pressure sustained by a bandage, will be sufficient to control the hemorrhage If possible, sterile gauze dressings should be used so as to minimize the possibility of infection (see Fig 29) If regular sterile dressings are not available the cleanest gauze available should be used As stated previously a freshly ironed handkerchief or towel is relatively sterile the towel or handkerchief should be unfolded so that a portion which has not been touched by anyone s hands will be placed directly into the wound Dry gauze itself tends to adhere to the wound and collect blood clots in the mesh of the gauze it is, therefore more effective in stopping hemorrhage than is wet gauze A bandage may be applied immediately over the dressing but usually it will be advisable to hold the

the wound with blood are essential To obtain most effective results the vessel should be compressed against the underlying bone proximal to the wound, occasionally it is also necessary to compress the vessels distal to the wound to obliterate veins and blood from collateral arteries Although control of hemorrhage by pressure over arteries conducting blood to the wound is frequently difficult unless done by one expertly trained, yet the method has a singular advantage, since cessation of bleeding can be accomplished quickly, when using a tourniquet a certain amount of time may be lost in finding material for a tourniquet and applying it

COMPRESSION OF THE COMMON CAROTID ARTERY For bleeding from wounds in the neck, the mouth, or the throat, this important vessel can be found by first feeling for the trachea (windpipe) in the middle of the neck and then running the tips of the second, third and fourth fingers horizontally over the neck until the pulsations of this large vessel are encountered If the patient s head is bent back by placing a small pillow under the shoulder blades, the carotid artery will become more superficial and will be very obvious at the inner edge of the large muscle (sternomastoid), which serves to bend the head forward (see Fig 31) Three fingers are placed on this vessel whereas the thumb is carried around the back of the neck Pressure should never be exerted toward the windpipe but toward the thumb In this way the vessel will be compressed against the spinal column This vessel supplies all the structures on the same side of the head and neck including most of the brain Prolonged pressure on it especially in patients over 45 may lead to damage of the brain Pressure should always be exerted at a point lower than the Adam s apple (larynx) At this point the vessel divides into its two main branches Pressure on this area may lead in certain individuals to slowing of the pulse a great fall in blood pressure and even a standstill of the heart The best site to exert pressure is in the lowest part of the neck, where the spinal processes become prominent

COMPRESSION OF THE BRACHIAL ARTERY This is the main artery of the arm Its pulsations can be felt in the groove behind the biceps muscle especially if the arm is lifted away from the body at right angles and the arm rotated outward so that the palm of the hand faces upward (see Figs 30 and 31) The artery is compressed against the bone at the middle third of the upper arm by grasping the arm firmly with three fingers in the groove at the edge of the biceps and the thumb on the outside When pressure is correctly applied the pulse at the wrist should disappear Pressure below this level is not indicated as branches of the brachial

the tendency to bleed Moreover, activity would be apt to scrape off clots as they formed, and would therefore tend to reactivate bleeding

2 Direct Finger Pressure in the Wound In extreme emergency, when bleeding is profuse, when the other, more desirable methods are either not available or the attendant *does not even have time to employ them*, pressure against the bleeding artery through the wound may have to be done as a lifesaving measure After quickly cutting or tearing off the covering garments, the first aid worker will have to place his fingers directly into the wound, preferably covered with a clean handkerchief or towel It may take a few trials to exert the pressure at a proper angle toward an underlying bone No attempt should be made to keep mopping the blood out of the wound as this interferes with the normal coagulation of the blood and greatly increases the likelihood of infection If the bleeding is successfully stopped by direct pressure in the wound the first aid attendant has a little time to collect his wits and look for other, more desirable methods to control bleeding He may get an assistant to apply a tourniquet if the site of bleeding is below the middle of the upper arm or thigh He may get somebody to place pressure on the artery between the wound and the heart Finally in certain locations, as deep in the lower end of the neck or high up at the root of the lower limb all such measures may not be applicable and the first aid worker will have to maintain finger pressure during transportation to an operating room until a surgeon can relieve him of his responsibility and control the bleeding by placing sutures or ligatures for permanent control of the hemorrhage While contamination of the wound may occur through such a procedure the patient's life is at stake and bleeding has to be stopped at the risk of infecting the wound

3 Direct Finger Pressure over Arteries Pressure over the bleeding point is much more effective in controlling hemorrhage than is pressure over the artery proximal to the wound accordingly it is usually advisable to utilize wound pressure as the first measure for control of the bleeding However, since pressure over the artery proximal to the wound may sometimes aid in controlling the bleeding this method will be described for a few of the important arteries

There are certain locations in which the use of the tourniquet is impossible or dangerous Thus bleeding from the head and neck, from the shoulder and armpit or from the groin and hip cannot be stopped by a tourniquet Also the bleeding may be so severe that immediate control by finger pressure is urgent

Speed and accurate knowledge of the site of arteries which supply

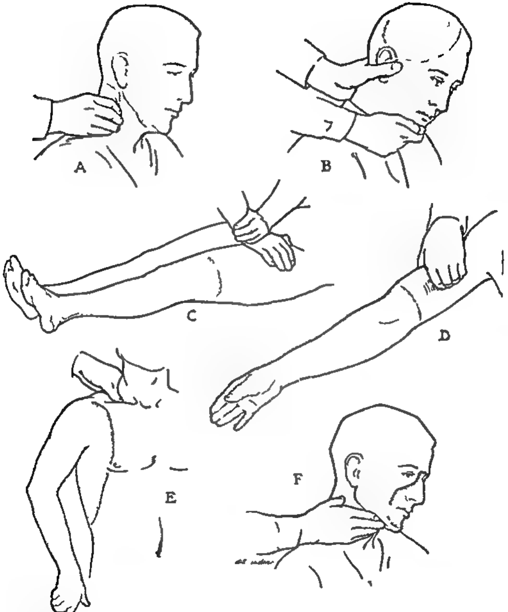


Fig 31 Illustration revealing the six major pressure points indicating compression of the artery for control of hemorrhage Pressure over A the carotid artery B temporal artery C femoral artery D brachial artery E subclavian artery and F external maxillary or facial artery The shaded portions represent the areas where the arterial circulation is impaired by the pressure As stated previously pressure directly over the wound with some type of pad is superior to pressure over the artery above the wound for the control of bleeding and with few exceptions should be tried first

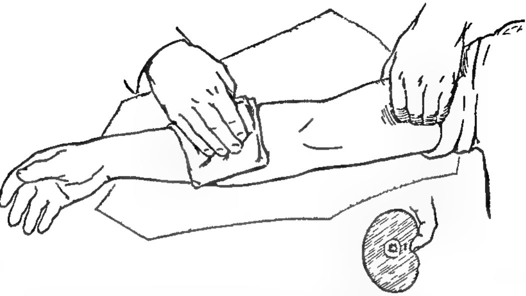


Fig 30 Bleeding from a wound controlled by pressure on the forearm The brachial artery may be compressed in the arm as indicated to assist in controlling the bleeding Insert shows how the artery is compressed against the bone

artery will continue to supply blood to the wound and can be controlled only by tourniquet

Compression of the Femoral Artery This is the main artery of the lower extremity It lies superficially in the groin and its pulsations can be felt easily even in obese individuals, if the middle of the inguinal fold (groin) is gently felt The artery can be compressed here against the flat plate of the pelvic bone (see Fig 31) The pulses in the foot should disappear when compression is adequate Only if the patient is very weak and has lost much blood will the pulse be feeble or imperceptible The entire palm of the hand will have to be pressed into the groin (see Fig 31)

Compression of Miscellaneous Arteries Lacerations of the scalp usually bleed profusely Although the major blood supply to the scalp is derived from the *temporal* and *occipital* arteries rarely will compression of these vessels control the hemorrhage because of the extensive collateral vessels A large pressure dressing over the wound is more effective The *facial* artery which may be compressed under the second portion of the mandible (Fig 31F) is a major vessel supplying blood to the face Compression of this vessel may be attempted but likewise may be ineffective in controlling bleeding from the face because of numerous collateral vessels Wounds of the axillary artery (in the armpit) and its major branches cannot be controlled by a tourniquet Compression of the

as satisfactory as a flat strip of rubber, since the flat rubber exerts a more widely distributed pressure and is not so apt to damage the tissue Before the tourniquet is applied, several layers of cloth such as a folded towel should be wrapped around the extremity for protection of the soft tissues at the site where the tourniquet is to be applied, likewise a pad should be placed at the site of the artery to be compressed The pad may consist of a tight wad of cloth, or a folded handkerchief or towel, if a stone or block of wood is used for the pad, it may bruise the artery and other important tissues severely However, one must be sure to locate the artery and place the pad directly over it, for if the pad is placed beside the artery, control of bleeding may not be secured In an emergency, however, too much time should not be wasted in hunting for the pad, as the tight, constricting bandage will suffice if applied at the correct point

If a nonelastic material such as a handkerchief is used, it should be wrapped around the previously elevated limb and a half knot tied Then place a short stick, a ruler, a policeman s club, a rifle barrel, a cane, or an umbrella on the half knot and tie a square knot over it Next, the stick is twisted rapidly so as to tighten the constriction but only tight enough to arrest hemorrhage One must be careful not to catch the skin in the twisted portion of the tourniquet The stick must be held in position by the ends of the bandage which is used for the tourniquet or by another piece of cloth looped around the end of the stick and tied around the limb (see Fig 33)

If a strip of rubber bandage or rubber tubing is available from a first aid kit the limb is elevated the left hand firmly grasps the end of the bandage whereas the right hand winds the elastic material, under steady pull around the limb The first turn must overlap the end of the bandage to prevent it from slipping Under continuous steady tension which has to be acquired by practice the entire band is wrapped around the limb It is secured by anchoring the loose ends of the bandage with a hemostat stout string or a hook and chain which is supplied with an Esmarch bandage (strong rubber tubing)

Errors in Applying a Tourniquet Errors are frequently made and often result seriously or even fatally for the patient

(a) *If the tourniquet is too loose* it will produce a bluish congestion of the limb and increase bleeding as the blood will continue to flow into the limb through the arteries but its return will be interfered with because of compression of the veins On the forearm and lower leg the application of the tourniquet is inadvisable as the arteries are partially protected by

subclavian artery just above the clavicle, as in Figure 31E, will control this bleeding However, compression of this vessel is difficult, particularly in stocky, short-necked individuals A lot of time should not be wasted in an attempt to control bleeding from this area if compression cannot be obtained readily, application of a pressure dressing similar to that shown in Figure 29 will probably be the procedure of choice Compression of the *popliteal artery* back of the knee is difficult and dangerous because of danger to nerve trunks in that region Compression of this vessel should not be attempted

4 **Application of a Tourniquet** A tourniquet is a constricting band placed around an extremity in such a manner that it can be tightened until all arterial blood flow has been stopped In general, there is a tendency for the amateur first aid worker to apply a tourniquet *more often than is necessary* It should be emphasized that although a tourniquet may be a life saving weapon, it nevertheless *is a dangerous weapon* particularly if it is put on too loosely, too tightly or left on too long as will be discussed presently in more detail

The two sites for placing an effective tourniquet are

1 Around the upper arm, about a hand s width below the armpit

2 Around the thigh about the same distance from the groin

A tourniquet should be a flat band at least one inch wide it may be a necktie, handkerchief towel scarf, or belt—never a rope, or wire, except when there is no other choice A wide flat rubber band, available in hospitals and in some first aid kits is the most effective and least painful Rubber tubing is more commonly used as material for tourniquets (see Fig 32) and is therefore more readily available however it is not

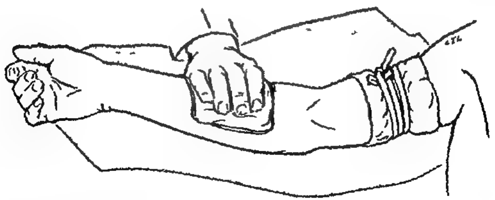


Fig 32 Application of a rubber tube tourniquet on the arm for control of hemorrhage in the forearm

as satisfactory as a flat strip of rubber, since the flat rubber exerts a more widely distributed pressure and is not so apt to damage the tissue Before the tourniquet is applied, several layers of cloth such as a folded towel should be wrapped around the extremity for protection of the soft tissues at the site where the tourniquet is to be applied, likewise a pad should be placed at the site of the artery to be compressed The pad may consist of a tight wad of cloth, or a folded handkerchief or towel, if a stone or block of wood is used for the pad, it may bruise the artery and other important tissues severely However, one must be sure to locate the artery and place the pad directly over it, for if the pad is placed beside the artery, control of bleeding may not be secured In an emergency, however, too much time should not be wasted in hunting for the pad, as the tight, constricting bandage will suffice if applied at the correct point

If a nonelastic material such as a handkerchief is used, it should be wrapped around the previously elevated limb and a half knot tied Then, place a short stick, a ruler, a policeman's club, a rifle barrel, a cane, or an umbrella on the half knot and tie a square knot over it Next, the stick is twisted rapidly so as to tighten the constriction but only tight enough to arrest hemorrhage One must be careful not to catch the skin in the twisted portion of the tourniquet The stick must be held in position by the ends of the bandage which is used for the tourniquet or by another piece of cloth looped around the end of the stick and tied around the limb (see Fig 33)

If a strip of rubber bandage or rubber tubing is available from a first aid kit, the limb is elevated, the left hand firmly grasps the end of the bandage, whereas the right hand winds the elastic material, under steady pull around the limb The first turn must overlap the end of the bandage to prevent it from slipping Under continuous steady tension, which has to be acquired by practice, the entire band is wrapped around the limb It is secured by anchoring the loose ends of the bandage with a hemostat, stout string or a hook and chain, which is supplied with an Esmarch bandage (strong rubber tubing)

Errors in Applying a Tourniquet Errors are frequently made and often result seriously or even fatally for the patient

(a) *If the tourniquet is too loose* it will produce a bluish congestion of the limb and increase bleeding as the blood will continue to flow into the limb through the arteries but its return will be interfered with because of compression of the veins On the forearm and lower leg the application of the tourniquet is inadvisable as the arteries are partially protected by

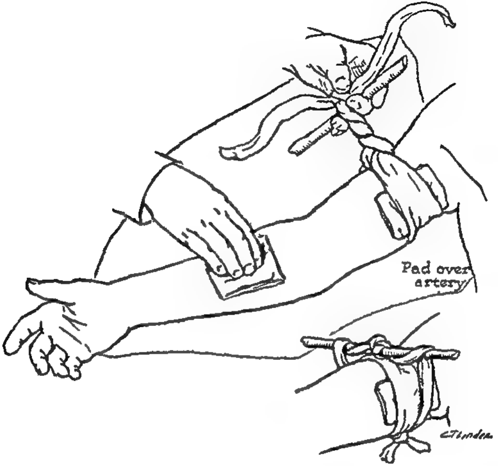


Fig 33 Application of a handkerchief tourniquet on the arm for control of hemorrhage in the forearm

the two bones of the forearm or lower leg and therefore they will not be compressed by the tourniquet Thus only venous obstruction will result Only on the upper arm and thigh where the artery can be *compressed against the bone,* is the tourniquet really effective Needless to say, a tourniquet should *never be applied to the neck* where it would compress the trachea (windpipe) and suffocate the patient If the tourniquet is too loose the pulse at the wrist or ankle will not disappear

(b) *If the tourniquet is too tight* it may cut through the skin or severely bruise muscles nerves and blood vessels It should be sufficiently tight to arrest all bleeding from the wound The limb below the tourniquet should take on a pale yellowish tint the pulse in the limb beyond the tourniquet, felt best at the wrist or behind the inner ankle must disappear

(c) *If the tourniquet is hidden* it may easily be left on too long The tourniquet must always be applied after the clothing is removed from the injured area The victim should have the letters 'TK' conspicuously placed (e g , on the forehead with ink), especially if he is transported without the first aid attendant, so that the presence of a tourniquet can be easily recognized This is especially important if the patient is unconscious or delirious

(d) *The tourniquet should not be left on longer than 30 minutes at one time* If the circulation is cut off for too long a time, the tissues die and gangrene develops If the tourniquet should be left on for several hours, the patient may suffer the loss of his leg or arm But, even shorter periods may result in severe nerve injuries with long-lasting painful sensations or paralysis Muscles and arteries may be badly damaged Therefore, the *tourniquet must be loosened for a few minutes every 30 minutes* without removing it from the limb If bleeding has greatly diminished or ceased when the tourniquet is loosened, a pressure bandage can be placed over the wound and the tourniquet left off If arterial bleeding recurs, the tourniquet again should be tightened after having been released for a few seconds During this time, bleeding from the wound may be partially controlled by direct pressure

SUMMARY

When confronted with hemorrhage from a wound the individual administering first aid should try to employ the simplest and safest methods at his disposal Capillary oozing will stop on gentle pressure with gauze reinforced with bandage Venous bleeding usually stops on elevation of the part and pressure exerted through a gauze bandage Arterial bleeding should be graded as to its severity Pressure bandage tourniquet, pressure over the main arteries at effective sites, and direct pressure in the wound are the methods available for the temporary control of bleeding While severe bleeding invites the utmost speed and quick decisions in the majority of instances simple pressure and elevation without undue haste will suffice *Remember not to shoot at a bird with a cannon!* The dangers associated with the application of a tourniquet are so real that the first aid worker should have strong indications for its use and should be well informed as to the precautions It should be emphasized that, in reality the need for use of a tourniquet is quite rare, even in areas of civilian bombing With few exceptions a pressure dressing properly applied, pre

ferably of the Gallagher type as illustrated in Figure 29, will be effective The battalion surgeon at the front line of an active fighting zone, where immediate control of hemorrhage is more necessary than under any other circumstances, finds that the control of hemorrhage by clamp and ligature or pressure dressing is safer and more practical than by tourniquet

8

Burns, Frostbite

PAUL W GREELEY

BURNS

Burns may be classified from the standpoint of etiology into the following convenient groups

1 Thermal and chemical
2 Sunburn and heatstroke
3 Electric
4 Radiation

Thermal Burns By far the greater majority of burns occur from the direct effect of heat The heat may be produced by one of several sources, namely fire hot liquids steam or explosion blasts Flash burns due to the explosion of gases and powder such as that produced by exploding bombs can produce severe damage even though the patient may be standing some distance away It should also be remembered that explosions severe enough to produce burns may likewise cause other simultaneous injuries, such as blast shock brain injury and fractures

Pathologic Classification Burns are commonly divided into three groups, depending upon the depth of skin damage However, it is more important that one know the extent of the burns rather than their depth It is felt that with first degree burns (as defined presently), when two thirds of the body surface is involved, the result will prove fatal Second degree burns may prove fatal in adults if more than one third of the body surface is damaged Children however, are more susceptible and death may occur if as little as one seventh of the body surface is covered with burns of second degree Any burns affecting one tenth of the body surface must be looked upon as serious The surface area however may be larger without fatal effects if modern therapy is judiciously calculated

The amount of surface area involved can be calculated by the so-called rule of 9 s (Fig 34) These figures will obviously aid in determining the prognosis of the burned individual The head and neck are calculated to be 9 per cent Each upper extremity is 9 per cent The anterior chest is

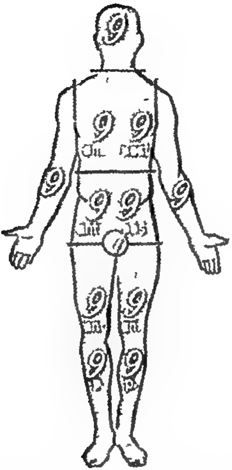


Fig 34 Rule of 9 s for estimating surface area involved in burns

9 per cent and the posterior chest another 9 per cent The anterior abdomen represents 9 per cent, while its posterior surface is an additional 9 per cent The anterior half of each lower extremity is 9 per cent and the posterior half of each lower extremity also 9 per cent The genitalia are considered 1 per cent

First degree burns are the mildest and produce only a reddening of the skin

Second degree burns represent the next stage in severity and are characterized by blistering of the skin Both second and first degree burns frequently occur simultaneously on the same patient It must also be pointed out that *second degree burns do not damage or destroy the complete* thickness of the skin This fact is important since if even only a small portion of the corium (deeper layer of skin) remains it will be

sufficient to produce spontaneous regeneration of the skin, so that later skin grafting will not be necessary Much has been written regarding the merits of various proprietary burn ointments, stating that if one of them is used, skin grafting will not become necessary Obviously, the individuals praising their particular brand of therapy have overlooked the basic fact which gave them success, namely, they were dealing with burns not deeper than second degree and spontaneous healing occurred from the undamaged deeper portion of the derma, not from the particular medication applied As will be discussed later it is felt that the application of any grease or oily material to the freshly burned surface may even be detrimental

Third degree burns cause complete destruction of the entire skin thickness This group also includes those which may involve damage or loss of the subcutaneous fat, fascia tendons, muscle, or even bone in addition to the total skin thickness This type of burn is of course the most serious, both from the standpoint of immediate illness and the late permanent damage, part of which can be corrected by plastic operations

Prophylaxis of Burns A word of caution in the prevention of burns would seem unnecessary On the other hand observance of seemingly simple precautionary measures should be emphasized even though everyone should know them

In the average household, small children should not be permitted access to boiling water, hot soups, coffee pots etc especially by thoughtlessly placing them near the edge of the stove or sink If it is necessary to have a tub of hot water on the floor, see that the children are kept away Matches and cigarette lighters must be placed out of the child s reach Inquisitive fingers can turn an innocent box of matches into a tragic burn Do not use inflammable cleaning fluids near an open flame or while smoking While it is common practice, smoking in bed is to be condemned since many serious casualties have followed this procedure Do not pour inflammable liquids into a coal or wood stove or attempt to find a leaking gas pipe with an open flame light The use of commercial fluids to start fires can only be condemned because of their explosive and inflammable nature

Factories in which explosive chemicals are used should be equipped with frequently tested cold water showers spaced at strategic points Should an explosion occur, much of the damage to the patient can be avoided if he can be quickly rinsed under the jet of water

Many painful sunburns can be prevented by the simple observance of gradually increasing one s daily exposure to the sun s rays

Certain industrial and military occupations demand that the person nel work in areas that are known to be potentially subject to explosion Burns following this accident usually are due to the flash that occurs While it may be more comfortable for these workers to wear a minimum amount of clothing such as shorts and no shirt, the practice should be stopped because of the added skin exposure should a flash explosion take place In general, ordinary clothing covering the skin (including gloves for the hands) is sufficient to protect the skin from flash burns of this type

Rescue From Fire Rapid and clear thinking are paramount in re moving a person from an actual fire Remember that the air near the floor is best Do not hesitate to crawl on the floor if the room is filled with smoke Tying a wet handkerchief over the mouth will keep out some of the smoke and at the same time minimize the risk of inhaling flames or superheated air *Remember however, that a moist handkerchief is not a gas mask* Unquestionably, more people succumb in burning buildings to the suffocating effects of gases from the fire than to the direct effect of flame and heat

A person whose clothing is on fire must not be permitted to stand Have him lie down and try to smother the flames with a coat rug or blanket covering the head first thereby minimizing the damage to the face and inhalation of flames and smoke

Treatment of Burns The principles involved in the treatment of burns include the following main items

1 Relieve pain
2 Prevent shock
3 Prevent infection
4 Actual treatment of the burned areas
5 Late plastic repair of cutaneous defects

From the standpoint of the person giving first aid, the most important points are to relieve pain and prevent infection and shock In severe burns the first aid treatment will spare the victim much suffering and make the work of the surgeon easier Ideally, the earlier the treatment begins, the better chance the burned individual has of recovering from his injury with the minimum amount of permanent deformity

Pain is to be relieved by medication adequate to control it Very simple first degree burns of limited areas may have their discomfort controlled by the use of one or two 5 grain aspirin tablets given by mouth Codeine, given in ½ to 1 grain doses either by mouth or hypodermic is still more effective But the majority of extensive burns will be very painful, and

for this type of patient, large doses of morphine should be given, preferably hypodermically One-fourth to one half grain of morphine may be given to an adult, while smaller doses are given to children Codeine and morphine are given only on advice of a physician

Shock is combated by first relieving the pain To permit the pain to continue may predispose to shock Naturally patients with severe extensive burns must be hospitalized and must be given adequate doses of whole blood or blood plasma Whole blood supplies the red blood cells needed to carry oxygen Furthermore, whole blood will help to combat the inevitable secondary anemia that always occurs within a few days Plasma will not serve as a substitute for whole blood but may be used to supplement it when large quantities are needed Plasma expanders, such as dextran may be used for the same purpose

Some patients will present symptoms of oxygen deficiency While some of these may be aided by oxygen administration it must be remembered that patients with extensive face burns may have actual respiratory obstruction due to edema of the larynx and glottis *An early tracheostomy may be a lifesaving procedure* in such cases and likewise adds much to the patient's personal comfort

Saline solutions are given sparingly unless strongly indicated since the increased concentration of salt may predispose to an uncontrollable edema of the tissues Plain water may be given by mouth with benefit to the patient if he is not nauseated

Should the patient be in shock, the pulse weak and thready, and the extremities cold and moist when first seen, he should be covered at once with warm blankets if a low air temperature has possibly been a causative factor in the low skin temperature However, the temperature of patients in shock should not be elevated too rapidly or too much, since heat causes vasodilation and thus might have a depressing effect on the blood pressure Moreover elevation of body temperature increases the metabolic processes in the tissues producing another condition undesired in shock

Strict adherence to fluid therapy formulas cannot be followed without watching the patient's general course A more reliable method of fluid administration is to observe accurately the urinary output through an indwelling catheter Hourly checks of the amount and specific gravity must be recorded Twenty-five to fifty ml of urine should be excreted per hour The specific gravity should be around 1 016 Higher rates of excretion are unimportant but lower amounts may indicate a renal shutdown If this cessation of urinary flow is due to a true lower nephron syndrome fluid and electrolyte intake must be reduced sharply This is a

complicated condition, the treatment of which is entirely outside the realm of the first aid worker

It must be remembered that the total blood volume of small children is less than that of adults Consequently the foregoing quantitative figures must be scaled down accordingly

Prevention of infection of the burned areas is extremely important Neglecting this point may lead to severe infection and possibly death The chief obligation of the first aid attendant in preventing infection is to apply a sterile dressing as soon as possible (Fig 35) All rings bracelets and other constricting jewelry should be removed promptly before swell ing occurs The physician combats infection by debridement (Fig 36) and the use of one of the antibiotic agents such as penicillin (intramuscular route preferred) or Aureomycin (oral or intravenous route) See Chapter 2 for dosage

Local treatment of the burned area will depend on material available and extent of the burn As a rule the danger of infection and serious com

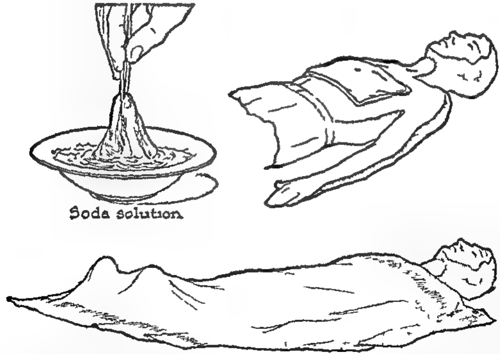


Fig 35 Dressing moderately severe burns The burn may be covered with sterile gauze moistened with soda solution or with a dry freshly laundered sheet or towel and the patient made comfortable for transportation or while awaiting the physician

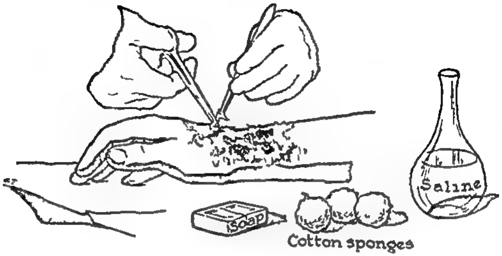


Fig 36 Debridement of burned areas (Definitive treatment not first aid) Foreign bodies and loose portions of dead skin are removed the area is then irrigated gently with saline preparatory to the local dressing Although careful debridement is advisable this procedure may be impossible when a large number of casualties are received at one time Experiences in the Boston night club fire (1942) revealed that results following minimum cleansing may be satisfactory if aseptic technic including masking of the attending physicians etc , is maintained during treatment

plications from burns is so prominent that any burn affecting more than a few square inches of skin surface should be referred to a physician as soon as possible If the burn is so extensive that the patient shows evidence of shock, he should be put to bed and a physician called or arrangements made to take the patient to a hospital While waiting certain types of local therapy may be instituted to make the patient more comfortable If the patient is hysterical or complains of severe pain, a sedative may be given Application of a cool wet cloth to the burned area is very soothing (see Fig 35) A soda solution (2 teaspoons of soda to a basin of water) or plain water may be used Water from the faucet is comparatively free from bacteria However the basin used for the solution should be scalded A freshly ironed towel while still folded may be dipped into the basin of water or soda solution and after it is saturated wrung out with the hands Unfolding the towel carefully so that the side coming in contact with the burned area is not the side touched by the hands will minimize infection If pain is not severe the burned area merely may be covered with a freshly ironed sheet or towel while awaiting the physician or transportation to a hospital

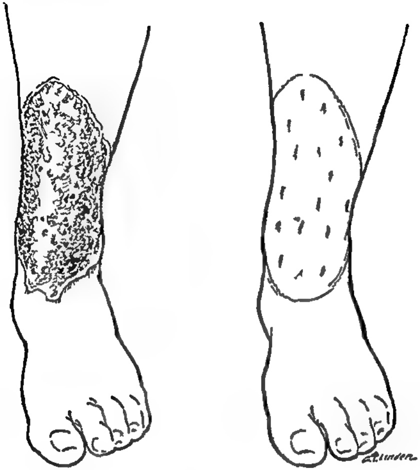
The application of burn ointments, salves, and other greasy materials directly to the burned surface is to be condemned While temporary comfort may be obtained, other factors outweigh its usefulness Allergic reactions may occur from certain burn ointments But more important is that when dealing with deeper burns, these ointments must be removed by the surgeon This may be difficult without the use of solvents and general anesthesia

Covering the burned area with pieces of fine silk or nylon is relatively harmless as well as comfortable This material can ordinarily be obtained by cutting up a lady s clean slip Over the silk or nylon compression dressings can then be applied If the patient is comfortable and temperature free dressings of this type are not usually disturbed for at least one week Earlier opening invites contamination and infection If the patient should develop an unexplained fever, the burn must naturally be exposed for observation and treated as indicated by the findings

Second and third degree burns are best covered with a freshly ironed towel or sterile dressings moistened with soda solution, and the patient referred to expert medical care at once (see Fig 35) *Further local treatment is then carried out by the physician* Under sterile precautions he will first remove all blisters and necrotic tissue (debridement) Next the skin adjacent to the burned area will be washed with plain white soap and sterile water, using cotton pledgets or gauze to minimize trauma The soap is then removed by rinsing with sterile physiologic saline solution (see Fig 36)

If the burn progresses without complication, the first dressing is done in seven to ten days If the damage has been superficial complete healing will have occurred during this period On the other hand, if full skin thickness or third degree destruction has occurred the necrotic tissue must be debrided and the underlying granulating surface prepared for early skin grafting (Fig 37) If a skin graft is not applied healing will take place very slowly with scar formation (see Fig 38) This in turn leads to contracture and dysfunction

Open Treatment of Burns The so called open treatment has considerable merit, especially when dealing with large numbers of burned patients when supplies and personnel may be at a premium The method consists in keeping the patient in clean surroundings, preferably in isolation, to prevent contamination If the burn is extensive enough to keep him in bed his sheets must be changed to keep clean As with all other burn therapy, personnel caring for him must be masked In one to two days all burned tissue will dry and form a protective covering over the wound



A B

Fig 37 Stages in the treatment of a third degree burn A the necrotic skin has separated leaving a granulation base B appearance of the area 2 weeks after skin graft

below This must be watched carefully for in a few days the crust will commence to crack and permit bacterial invasion As soon as this occurs, one must then debride all loose crusts as they separate If the burn is superficial healing will be observed below If third degree destruction has occurred preparation for early skin grafting must be started as soon as the crusts have all been removed

The most important warning in using the open treatment is not to let it become no treatment Too often these patients are neglected and their burns permitted to become severely infected

Burns that are first seen when over twenty-four hours old are poten-

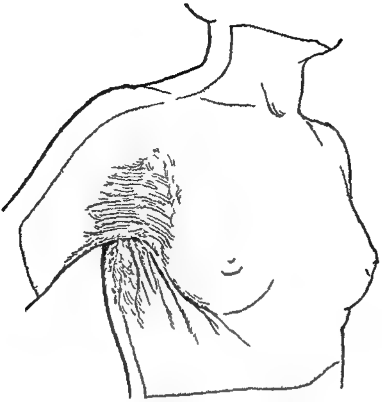


Fig 38 Dense scar in the axilla resulting from a third degree burn Application of a skin graft at the proper time as indicated in Figure 37 prevents this contracture and disability The scar as illustrated may be excised and a skin graft applied

tially infected and should be sent to the physician for special consideration This group and those already infected must be treated in a manner similar to that carried out with other infected wounds and *must not be treated by any tanning method*

Burns of the eye may be secondary to heat or chemicals and should also receive special consideration If the chemical is an acid the lids should be held open and the eyeball irrigated with a weak baking soda solution (1 teaspoonful of baking soda* to 1 quart of warm water) or even plain water If the offending agent is an alkali such as lime or cement, use plain water as an irrigant A few drops of olive oil, mineral or castor oil may then be dropped into the eye and the eye covered with a dressing The patient should then be sent to an eye specialist at once

*Do not add the soda to hot water or boil the solution since heating converts the bicarbonate into carbonate a very alkaline solution

The eye specialist may further relieve the local discomfort, or the person giving first aid may do likewise, if his equipment permits, by instilling 2 per cent Butyn ophthalmic ointment under the lids If this is used, the patient *must be cautioned against rubbing his eyeball* for a few hours thereafter Since Butyn produces local anesthesia, the cornea might be inadvertently injured without his knowledge

All patients who have inhaled hot air flames, or chemicals must be observed very closely and therefore need hospitalization This type of injury may produce severe complications in the trachea (windpipe) and lungs which might eventually cause pneumonia and death *A tracheostomy may be lifesaving*

Chemical Burns The accidental contact of strong acids or alkalies to skin produces changes that are very similar to those resulting from heat It is important, however, to ascertain in all cases of chemical burns the nature of the offending material so that intelligent treatment may be given Acid burns may first be neutralized with a mild alkali (e g , 5 per cent sodium bicarbonate solution), while alkaline burns may be rinsed with weak acids (vinegar—3 per cent acetic acid) before starting other active treatment *Damage is so frequently produced by neutralizing agents* that washing the burned areas with a generous amount of water (e g , under a shower or water hose) is preferable Clothing soiled with the offending chemical should, of course be removed Carbolic acid burns are best neutralized by alcohol, ordinary rubbing alcohol is adequate for the purpose

After local treatment (including chiefly irrigation) of the burned area a sterile dressing is applied and the patient sent to a physician since chemical burns may be very deep and tend to heal slowly Convalescent care consists chiefly of prevention of infection by chemotherapy and application of wet dressings, after healthy granulations are present and infection is trivial a properly selected skin graft is applied

Sunburn and Heatstroke With the onset of warm weather a large portion of the population seek out-of-door activities which bring them into the direct exposure of the high rays of the sun In addition many soldiers may be transferred to tropical climates after earlier training in the north Laborers may obtain new employment that takes them out of doors into the sunshine after previous inside occupations All of the above groups must be careful to expose their skin gradually to the sun lest burns of varying degrees result The damage to the skin is similar to that produced by other thermal agents but is usually first and second degree in character Treatment consists in using a bland petrolatum ointment con-

taining some type of mild anesthetic or cooling agent, such as menthol (0 5 per cent), *which will be quite effective in relieving the pain* Heavy oil of petrolatum itself will be helpful, since exclusion of air from the burned areas seems to relieve pain Application of a heavy paste made of water and sodium bicarbonate is likewise helpful If necessary, aspirin or codeine may be given to alleviate the discomfort Wet, cold packs are also very soothing

Heatstroke (*sunstroke*) must be considered with sunburn, since the two may occur together Heatstroke may also be secondary to prolonged exposure to hot working conditions, such as in steel mills, blast furnaces, and the like These individuals may complain of pain in the head, dryness of the mouth and skin, and sometimes dizziness Loss of consciousness may occur Poorly treated or neglected patients of this type have a very high mortality rate (see Chapter 21)

Differentiation must be made between heatstroke as just described and *heat exhaustion* the latter of which consists primarily of *dehydration and chloride depletion* produced by excessive perspiration The prophy lactic ingestion of 5-grain sodium chloride tablets 3 or 4 times daily may prevent many cases of heat exhaustion among those working in hot areas They are discussed in detail in Chapter 21

Electric Burns Burns of this nature may follow contact with a charged electric wire electric apparatus, or result from a bolt of lightning The victim must be freed from contact as soon as possible *Use a dry stick rope coat or other dry nonconductor* The person rendering first aid must never use his own hands without protection It is dangerous and may add another victim to the tragedy Naturally, when possible the offending electric current should be interrupted at once

Electric burns vary tremendously in type some are diffuse and shal low, whereas others are localized and deep It is therefore impossible to tell from the appearance of the burn just how serious it is Burns with a small surface sometimes char and desiccate the tissue for an inch or two along the path of the current s discharge First aid treatment to the burned area is of small consequence since the most serious phase of electric injury is the damage inflicted on the heart and respiratory center either of whose functions may be destroyed (see also Chapter 13) If respirations have ceased artificial respiration should be started im mediately (see Chapter 13) and continued for at least 60 to 120 minutes before giving the patient up as dead The actual burn is therefore, of secondary importance, the chief item in its care is to apply a sterile dress

ing If no significant damage is inflicted on the heart or respirations, the physician may perform a debridement in the hospital

Radiation Burns (Atomic Blasts and X-ray) Although the radiation effects of atomic blasts are extremely damaging to the human body, there is rarely any indication for first aid therapy because the radiation effects resulting from the exploding atomic bomb are not instantaneous Demonstrable effects may not be noted for days or weeks However, the people subjected to the blast of an atomic bomb are apt to be burned superficially from the heat of the exploding bomb These burns are thermal burns and may be treated as described previously in this chapter, except that decontamination (i e, removal of clothing and washing the body free of irradiated particles with water, etc) must be *accomplished without delay* to prevent a severe or fatal irradiation burn (see also Chapter 10) Burns may develop from overexposure to the x-ray, but are likewise slow in development, accordingly, first aid is never necessary in such accidents

FROSTBITE

The areas of the body most commonly affected by freezing are the toes ears, nose, and fingers, with an incidence about in the order named Everyone is probably familiar with the fact that as tissue freezes it begins to tingle becomes numb and finally totally anesthetic Frozen tissue can be recognized readily by the white color Since freezing results in tissue destruction it is a serious accident, the tissue becomes gangrenous and either drops off eventually or is amputated

It should be emphasized that rather serious effects of cold can result without actual freezing of tissue Prolonged exposure to cold on numerous occasions for several hours at a time often leads to pain in the parts (usually fingers or toes) associated with an uncomfortable tingling sensation this is known as *chilblains* Many aviation personnel have suffered serious freezing of their hands and fingers following the short time in which they may have removed their gloves while flying at high cold altitudes Obviously this practice should not be permitted Treatment is very unsatisfactory but will rarely be presented as a first aid problem Another type of damage induced by cold is *trench foot* a condition rather common in World War I resulting from exposure of the feet to cold in damp or wet shoes which could not be removed for days at a time *Immersion foot* is a condition of the feet observed in World War II, resulting from prolonged exposure of the soldier or sailor to icy water The skin of the feet becomes cyanotic and blisters appear, the temperature

of the surface of the feet remains below normal Gangrenous areas may appear Treatment is limited, but exposure of the feet to cold air or immersion in cold packs improves the condition of the circulation Limitation of activity and aseptic care of the feet are indicated until the condition is relieved The two most important features in first aid are not to allow the victim to walk upon his feet and not to apply heat to feet

Treatment of Frostbite Naturally, as soon as it is discovered that any portion of the body is frozen the patient should be removed from freezing temperature as soon as possible To prevent extravasation of fluid (blood serum) into the tissues which may result in marked swelling actually jeopardizing the blood supply of the remaining viable tissues, it is necessary to thaw out the frozen area slowly The age-old custom of *massaging the area with snow is dangerous and should not be resorted to,* since the tissues in the area are so fragile that even mild massage would result in destruction of tissue and an increase in the gangrenous process It is preferable then to put the patient in a cool room and allow the frozen part to thaw out slowly without manipulation If the affected parts are fingers or toes they may be placed in cold water every few minutes for a short interval so that a gradual and slow thawing will be assured After the frozen tissues are thawed out it is still important that the patient not apply heat since it has been shown (Brooks and Allen) that heating tissue increases the metabolic processes in the cells to such a degree that the necrosing process may be increased

The gangrenous tissue which develops within a few days after freezing may be amputated but will drop off spontaneously after a week or two The latter event is usually allowed to take place since more tissue will in most instances be saved by this procedure

If entire extremities such as feet and hands are frozen medical aid should, *of course* be sought as soon as possible *Freezing of this much* tissue is very shocking moreover the extravasation of fluid (blood serum) into the tissues as they thaw out increases the shock Hot, stimulating drinks (not alcoholic) should be given as the frozen extremities are allowed to thaw out slowly and gradually Transfusion of blood or blood plasma may be necessary to combat the shock which usually results The utmost cleanliness of the affected parts must be maintained, since the gangrenous areas become infected readily Accordingly, from the prophylactic standpoint one of the antibiotic agents such as penicillin or Aureomycin should be given in moderate doses When frank infection develops larger doses should be given

9

Transportation of the Injured

LINDON SEED

DETERMINATION OF THE TYPE AND SEVERITY OF INJURY

When a person is injured much is to be done before he is moved Most likely you have happened upon the scene of an accident you are not known to the injured or to the spectators It is well to state promptly, 'I am a physician' or I am a first aid worker A simple statement of your qualifications will obtain the immediate cooperation of the gathering mob If this is not done in a few moments a dozen top sergeants self-appointed from the crowd, will begin giving countermanding orders A few experiences will soon teach you that a crowd in the presence of an accident behaves as a childishly illogical and at times, dangerous mob A loud hysterical voice will give foolhardy advice which if you do not heed will bring down upon you the wrath of the spectators Ask the injured individual how he was hurt and where he hurts Then examine the injured area Never stop here but go through a complete although cursory examination beginning at the head and ending with the feet Feel about the scalp for cuts bruises and depressions Look for bleeding from the nose and mouth Feel both collar bones Ask the patient if he can move his arms Gently grasp his right arm and move it upon the shoulder, the forearm upon the elbow, and the hand upon the wrist then the left arm in a similar manner Place one hand on each side of the chest and squeeze gently upon the ribs If they are fractured the patient will complain of pain Feel along the back then with a hand on each hip squeeze upon the bones of the pelvis Ask him to move his legs Grasp the right thigh and move it gently upon the hip the leg upon the knee the foot upon the ankle then the left leg in a similar manner Look for bleeding It is not necessary to disrobe the patient unless blood is encountered when one must look for the wound If the patient is unconscious it may be assumed that the principal injury is to the head but this does not relieve one of the responsibility of looking for other injuries that might be ag-

gravated by careless handling, the examination, however, must be carried out in a gingerly manner If when moving an extremity you feel the peculiar grating sensation of two ends of a broken bone rasping one upon the other, restrain your curiosity Make no further movements If there *is any deformity of an extremity evidence of severe local injury, or* merely a loss of function, or if the patient says something 'snapped,' treat as a fracture No harm can ensue from splinting great harm may follow if it is not done in the presence of fractures

Walking Wounded The custom of dividing military casualties into *walking wounded* and *litter wounded* can also be applied to the injured in civil life The walking wounded are those who can walk by themselves for short distances and can be transported in a sitting or semi sitting position In an emergency an individual with a fairly severe facial injury without much loss of blood, can be transported a short distance in a sitting position indeed may be more comfortable sitting than lying If a fracture of the forearm arm, or clavicle is the only injury, the arm may be either bound to the side or placed in a sling and the patient driven to a hospital in a passenger car Patients with mild chest injuries can also be transported in this manner In fact, if the patient can walk and get into the back seat of a car by himself, he can usually be classified as walking wounded Be sure there is no injury of the spine pelvis or lower extremities It must be remembered that any injured person easily becomes weak and faint, and it is necessary to have an attendant in the back seat with him If he does collapse he can be supported by the attendant in a transverse position on the seat

Litter Wounded If the patient is seriously injured, classify him, if possible into one of the following groups 1, the unconscious patient 2 injuries of the head and upper extremities 3 the chest, 4, the abdomen, 5 the spine and pelvis, 6 the lower extremities Move the patient as little as possible Cover him with coats or blankets and then survey the situation Of the approximately 100 000 fatal accidents occurring yearly in the United States, about 40 per cent involve motor vehicles, 30 per cent are in the home 15 per cent are public accidents 15 per cent are at the place of employment and a very few are associated with major catastrophes (Accident Facts National Safety Council Chicago 1958) Thus the probability is that the situation in any particular accident will involve the street the highway or the home These are the places from whence you will ordinarily be looking Send someone to call for an ambulance or the police both the city and the state police are well trained and well organized to take care of accidents If organized help will arrive quickly, by

all means wait for it Not infrequently a seriously injured person is dumped into the first passing automobile and rushed pell mell, dead or alive, to a hospital, or what is worse, to a doctor's office The careless transportation of an injured person can cause irreparable damage Many occasions will arise when it is better to cover the patient well and leave him for a considerable period of time awaiting a litter or an ambulance Be sure he is kept warm Injured people do not tolerate cold If he is faint or unconscious, the body should be placed so that the head is lower than the feet If a number of individuals are involved in the accident, and if there is a choice of hospitals, it is wise to phone ahead Even three severely burned patients, for instance, may tax the facilities of a fairly large hospital And if a fourth one is received, he may have to be transferred to another institution If organized help is not available, see what means are at hand to accomplish your task Ask for the things you need When everything is prepared proceed with the best method of splinting and transporting that the circumstances permit It is assumed that a careful examination for the existence of fractures has been made and proper dressings and splints applied as described in Chapters 5 and 11

Major Catastrophe In the event of a huge catastrophe, such as an explosion of an atomic bomb in a metropolitan district the injured must be moved by whatever means can be improvised to a sheltered collecting point accessible to wheeled transportation or helicopter lift The sequence of events will be as follows (Hughes, H L G Irish J M Sc , pp 357-366, 1957)

1 Rescue squads
2 Stretcher squads
3 Collecting sorting, or first aid stations
4 Transportation by ambulance or helicopter

Rescue squads will extract the injured from demolished buildings and carry them by hand over the rubble to a spot where litter carry is possible The patients are then placed on improvised litters and transported to the first aid station where also the walking wounded are directed If one has not already been designated choose a place with the two prime requisites 1, a covered spot which will shelter the wounded from radioactive fall-out and radioactivity 2, a place accessible to automobiles and/or helicopters Transportation from the collecting station will largely be by means of improvised ambulances and cannot be accomplished until the route of travel and point of destination has been indicated by a higher echelon

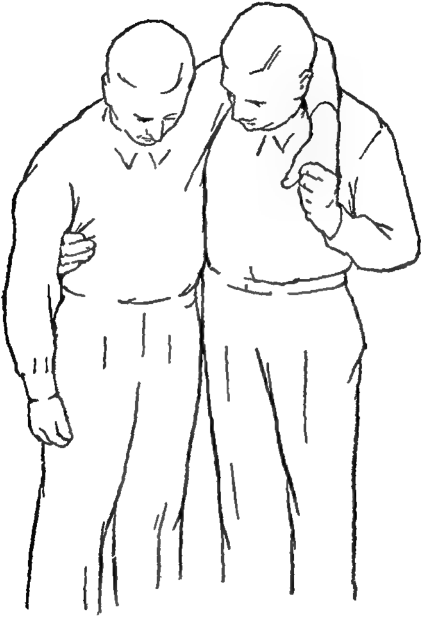


Fig 39 Method of support in walking

HAND CARRY

The hand carry is primarily a part of rescue work and is indicated only when immediate movement is mandatory The one-man hand carries are feats of strength impossible of accomplishment unless the rescuer

is of great strength, or the patient is of little size Even the two man carries require considerable strength In ordinary accidents, where help is available, the severely injured should not be moved by less than three or four carriers Even under favorable circumstances, the maximum distance of the movement is in the neighborhood of 150 feet In the following description free use has been made of these references Military Medical Manual Harrisburg Pa Military Service Pub Co, 1940, Fletcher, N C Transport of injured persons, Practitioner, 147 518, 1941, Goldsmith, R Improved dressings and transportation, M Clin North America 25 1761, 1941

Supporting or Human Crutch If the victim is conscious and merely needs support, he may be aided in walking (see Fig 39) by lifting him to his feet Then, standing on one side of him and facing in the same direction, pass his arm nearest you across the back of your neck and bring his hand well down on the front of your chest, supporting it with your corresponding hand Your other arm can be passed around the victim s waist for additional support

Shoulder knee Arms Carry This is also a one man carry If the victim cannot walk but is sufficiently responsive to hang on with his arms, he may be carried in the arms by the shoulder knee carry (see Fig 40) If he is not too heavy, you may be able to place him upon his back, kneel on one knee, slide one arm well under the knees the other under the back of his chest and raise him first to your knee, then roll him against your chest and stand If the patient can place his arms around your neck and hang on, it lessens the carrier s burden If the injured person is heavy and unconscious, it is more difficult to get him up into your arms This can be done by placing him in the prone position then straddle him facing his head, and lift him by the armpits When he is raised to his knees slide your arms down around his chest and raise him to his feet Then work around to his left side and support his knees with your left knee Then pass his left arm around your neck holding it with the left hand Assume a squatting position with the victim sitting on your right knee Pass your right arm around his back and your left arm under his knees and roll him against your chest

Two or Three man Arms Carry This is the simplest and easiest of all hand carries Three men designated as A, B and C line up on one side of the victim A places his hands under the head and shoulders B under the back C under the pelvis and thighs At A s command, all lift the patient in unison high up onto the carriers' chests and shoulders The same carry by two men is illustrated in Figure 41

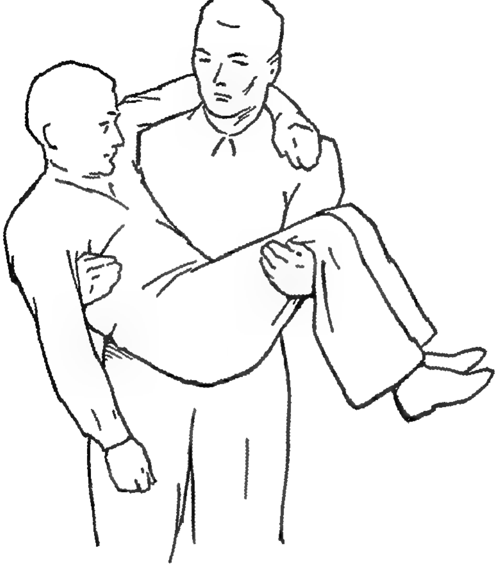


Fig 40 Shoulder knee arms carry

Eight man Carry When a victim is badly injured and one desires to disturb him as little as possible six or eight carriers may transport him by hand carry Three or four carriers kneel on each side of the victim passing their hands beneath him All arise slowly and simultaneously at a given time

Pack a back Carry This consists of getting the victim onto your back in a position where all four of his extremities are supported (see Fig 42)

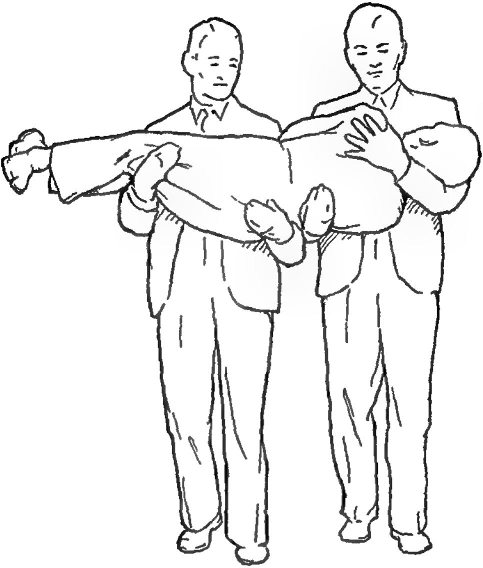


Fig 41 Two man arms carry

It is usually necessary that the patient be able to aid in the maneuver After raising him to his feet, move in front of him with your back to him Lean forward letting his weight rest upon your back 'Hunch him up high onto your back, then pass one arm at a time outside and around his corresponding thigh Let the patient s arms cross over your chest and grasp his right wrist with your left hand and his left wrist with your right hand

Pack strap Carry If a patient to be carried is on a bed or in a chair, the pack-strap carry often is convenient and handles him less roughly

Fig 42 Pack a back carry

(see Fig 43) Stoop in front of the patient with your back toward him Bring his arms over your shoulders pulling his chest tightly against your back Pull his hands together as low as possible in front of your chest, where they may be held with one or both hands The carrier then may walk with his back bent forward with little disturbance to the patient

Back Carry If an unconscious victim is large and heavy it may be almost impossible for one individual to lift him into an erect position and then transfer him to his back In such a situation the back carry may be useful With the victim lying on his back the two wrists are tied together

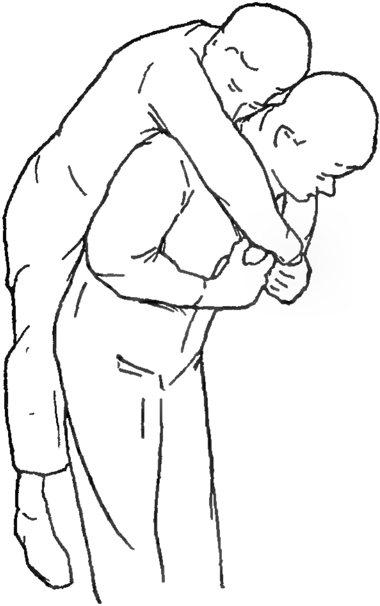


Fig 43 Pack strap carry

The rescuer then slides his head and left arm and shoulder from below through the loop formed by the two tied arms He should then lie with his back against the left side of the victim s body and parallel to it Reaching around with his left hand he grasps the victim s right elbow and with his right arm grasps the thigh pushing upward with the right foot which has been placed between the victim s legs (see Fig 44A) The carrier

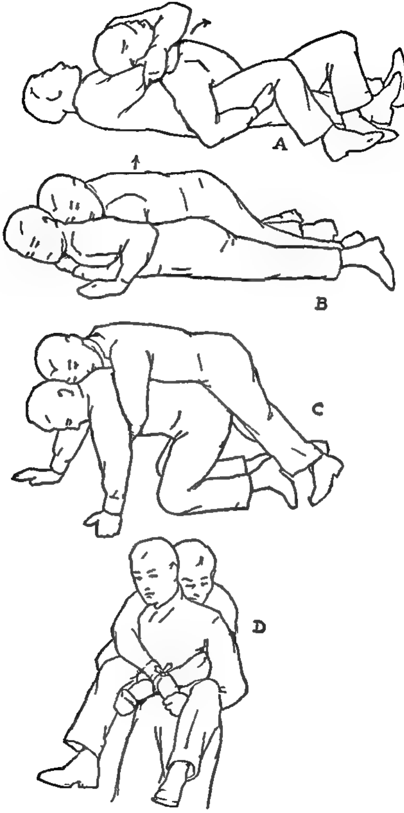


Fig 44 Back carry

turns over on his left side and then onto his abdomen, pulling the victim onto the carrier s back (see Fig 44B) After raising himself onto his hands and knees (see Fig 44C), and then to a squatting position, one arm at a time is passed around the corresponding thigh, and each hand of the victim is grasped by the opposite hand of the carrier (see Fig 44D)

Fireman's Carry One of the widely used methods of carrying an unconscious patient is called the fireman's carry Two methods of getting the patient into a final position for carrying are recommended In both the patient is placed in the prone position, face down In the first (see Fig 45A) the carrier kneels on one knee at the head of the victim and facing him One hand is placed under each shoulder and gradually slid down the side of the victim s chest and across his back The victim is raised to his knees (see Fig 45B), when a firmer grasp is taken across the back and the victim is raised to his feet, the carrier standing in front of him The victim then may be supported by placing the left leg between the victim s legs, and with the right wrist held in the carrier s left hand, the victim's arm is brought around the back of the neck (see Fig 45C) Reaching down, the right arm is passed around the victim s right thigh (see Fig 45D), the left hand then grasping the patient's right wrist The carrier then stands up with the victim riding across his shoulders (see Fig 45E) The victim s right hand may be transferred to the carrier s right hand thus freeing the carrier s left hand When the carrier wishes to place the victim back in a horizontal position, he may kneel on his left knee support the victim s body on his right knee (see Fig 45F), and gradually slide him to a horizontal position on his back supporting the head and shoulders with the right arm (see Fig 45G) so that the patient may be put down gently

In the other method, with the victim in the prone position, the carrier stands astride the body at the level of the lower chest and faces the head The hands are placed under the armpits to raise the victim to his knees and then are placed around the chest or waist to raise him to his feet With the left hand, the carrier grasps the left wrist of the victim drawing the arm around his neck and at the same time supporting the body with his right arm around the waist The right wrist is then grasped with the left hand The carrier s right arm is passed around the victim s right thigh drawing the latter s body across his left shoulder The victim s right wrist is then transferred to the right hand leaving the carrier's left hand free to help raise him to an erect position For additional support, the victim s left wrist may be drawn around the carrier s left arm and supported by the left hand

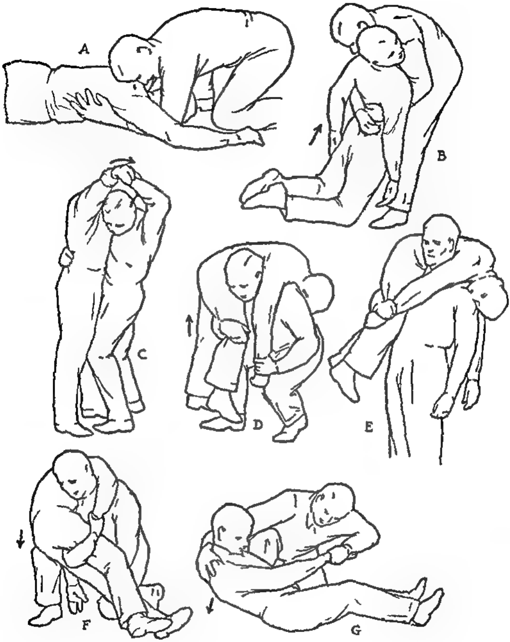


Fig 45 Fireman s carry

The Fireman's Drag (Fig 46) This carry is designed to move an unconscious patient when the carrier is unable to stand in a vertical posi tion The patient is placed upon his back his wrists securely tied together The carrier then straddles him on his hands and knees and places the

victim s arms around his neck By raising his shoulders, he is able to lift the victim s head and shoulders from the ground or floor and may then crawl forward dragging the victim beneath him The victim s head may be kept from dragging upon the ground by pulling his coat collar up under the back of the neck and head

Fore and aft Carry Here, with the patient lying upon his back, one carrier stands at his head, the other between his knees, both facing toward his feet The carrier at the head raises the patient s head and shoulders and either grasps the patient under the armpits or passes his arms under the armpits and clasps his own hands in front of the victim s chest The

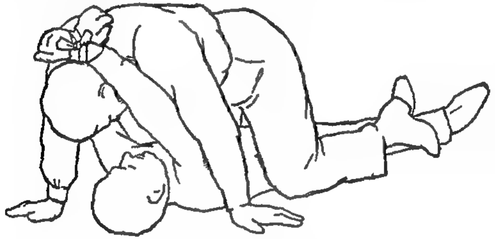


Fig 46 Fireman s drag

other carrier passes his arms around the victim s knees from the outside Both men then lift together (see Fig 47) This method of carry should not be used in cases of fractures or other serious injuries especially injuries to the spine

Two handed Seat When a patient is not badly injured and is able to cooperate in his transportation a seat may be made for him by the hands of two carriers Two bearers face each other and interlock their fingers, one man using his right hand, the other the left The disengaged hands then grasp the clothing of the opposite bearer thus making a support for the back of the patient The whole constitutes something like a chair' (Fletcher)

Three handed Seat Two bearers face each other The first then grasps with one hand his own other forearm two inches above the wrist and with his disengaged hand grasps the lower part of one forearm (also

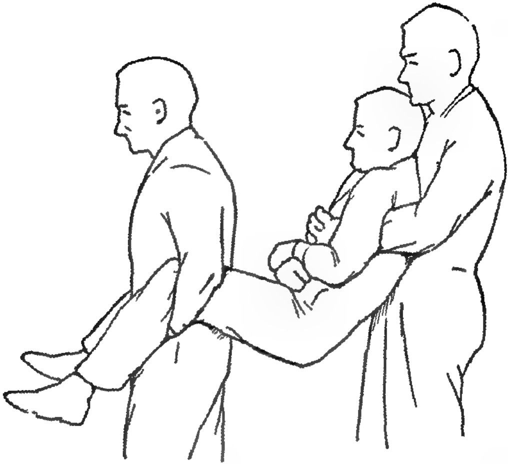


Fig 47 Fore and aft carry

two inches above the wrist) of the opposite bearer who in a similar fashion grasps the first bearer s free forearm This leaves one man with a free hand with which he can support the patient (Fletcher)

Four handed Seat Two bearers face each other Each grasps with his right hand the lower part of his own left forearm and then each with his disengaged hand grasps the lower part of the forearm of the opposite bearer (Fletcher) The patient supports himself by placing his arms around the bearers necks

Chair Litter A chair may very conveniently be used as a litter by two carriers (see Fig 48) With the patient seated in the chair one carrier stands in front of the chair with his back to it and grasps the lower end of the two front legs The other carrier stands in back of the chair grasping the top corners The chair is then lifted off the floor the carrier at the

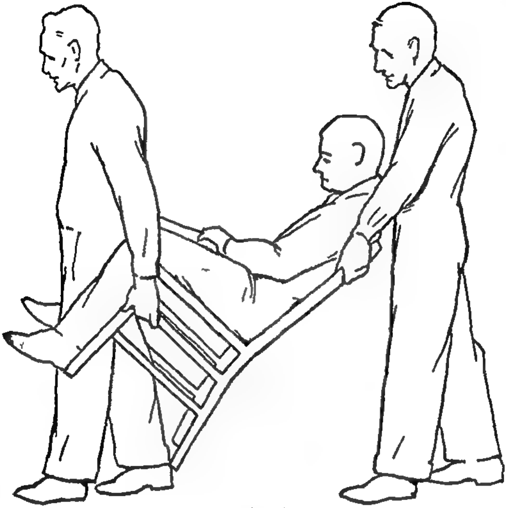


Fig 48 Chair litter

back supporting the victim s head and shoulders against his chest or abdomen

LITTER CARRY

Litters Some form of litter is far superior to the hand carry Inquiry may locate one in the vicinity of the accident Otherwise one must be improvised It may be made of one wide or several narrow boards nailed together If the cross pieces at either end project laterally, they can be conveniently used as handles for a four man carry A window shutter a door, or a ladder properly padded will be satisfactory An automobile seat may be used to support the body of the victim if an additional

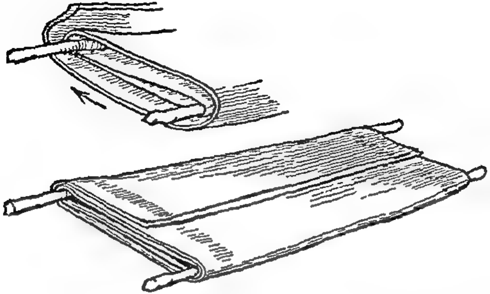


Fig 49 A method of folding a blanket around two poles to make a litter

carrier can support the feet A contour chair with an aluminum frame makes an excellent stretcher A canvas lounging chair or deck chair, or a light chaise lounge may suffice If two long poles can be found, a litter can be made by folding a blanket over them as shown in Figure 49 The blanket is doubled over with one pole in the folded edge Both edges are then folded over the other pole and if the blanket is wide enough, it is folded back over the first pole The litter is placed so that the patient's body rests on the free edge of the blanket and holds it in place If a blanket canvas or sheets are not available a coat and vest (see Fig 50)

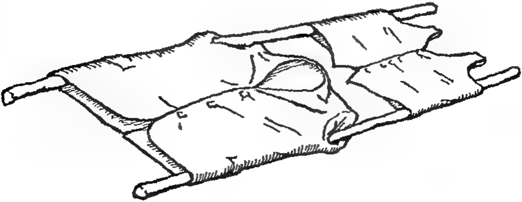


Fig 50 Coat and vest litter

or two coats may be placed over the poles The sleeves are turned inside out within the coat, which is buttoned, and the poles are inserted through the sleeves The neck of each garment should face in the same direction If a blanket is available but poles cannot be secured the victim may be placed upon the middle of the blanket and the edges rolled in from each side Three or four men on each side then can carry the blanket litter by grasping the rolled edges There is no national or international standard for stretchers A national standard would certainly be advisable, so that all stretchers would fit all improvised ambulances There are many variations, such as wheeled stretchers used in the modern ambulances stretchers with leg supports that can be used as "stretcher beds,' stretchers for mountain casualties and for transport from ship to ship collapsible litters, and the ordinary rigid litter with a canvas support

Loading the Litter Four-man loading is carried out as follows Three men line up on one side of the victim, usually the uninjured side and all kneel on the knee nearest the victim's feet Working in unison and at the orders of one person, the victim is rolled slightly away from the carriers who then slide both hands under his body at their respective locations The fourth man slides the stretcher beneath the patient who is then gently lowered on to it If the carriers must carry the patient a short distance to the litter they arise in unison and carry him carefully against their chests, as described under Two- or Three man Shoulder Carry' The litter is dressed usually with two blankets Each blanket is folded so that two layers lie upon the litter and the free edge overhangs the side When the patient is placed on the litter the free edges are folded over him so that he has four layers beneath and two on top If blankets are not available cover him with anything that is available never let him become cold

In removing the victim from the litter, the same procedures are carried out in reverse order The litter is lowered carefully Three men again line up on one side and lift the patient first to their knees then to their chests to carry him to a hospital cart bed or other place of destination

In a two man loading the bearers stand astride the victim and lift or slide him over onto the stretcher The simplest way to load on to a blanket is similar to that used by a nurse in changing the sheets under a bed ridden patient The blanket is partly rolled and placed against the patient who is rolled away from it about an eighth of a turn the blanket is shoved beneath him and he is then rolled back over it If there is any suspicion of a spinal injury he should be carried face down

In most instances the patient lies flat on his back, but the position and method of loading may vary according to the type of injury The *recommendations of the Sub-Committee on Transportation of the Injured of the American College of Surgeons* are as follows (Hampton O, Jr J A M A, 164 1381, 1957)

UPPER EXTREMITIES Patients with injuries only of the upper extremity are usually more comfortable during transportation in the sitting *rather than the recumbent position*

LOWER EXTREMITIES The Committee advises fixed traction utilizing a Thomas or a hinged half-ring splint Improvised coaptation splinting is highly acceptable A pillow may be bandaged about the leg or as a last resort the leg bandaged to the uninjured extremity

CERVICAL SPINE *In suspected injuries of the cervical spine* the patient should be transported face-up on a hard surface with a small rolled towel beneath the neck and preferably with sand bags or other heavy material on each side of the neck Flexion of the neck must be avoided

THORACIC SPINE Patients should be transported somewhat in the *position they are found If a casualty is found face down he* should be lifted to a hard surface and kept face down If he is found lying face up he should be lifted to the stretcher in this position When a patient with any injury of the spine is moved he should be moved en masse or in one solid piece, so to speak without imparting any motion to the neck or trunk Flexion must be avoided at all costs In spinal injuries of the trunk if the patient lies on his back support should be placed beneath the curve of the spine If there is a doubt as to whether the patient should be on his back or abdomen the latter is preferable

UNCONSCIOUS PATIENTS These are preferably transported in the semiprone position so that nasopharyngeal blood and secretions will run out of the mouth and nose and not be aspirated Other positions are chosen only when demanded by concurrent injuries of other parts of the body Open wounds on the head are merely covered with a sterile or clean dressing

Carrying the loaded stretcher requires a surprising amount of strength and endurance If possible always use four men Two men can carry an average sized adult no more than a few blocks four men with rest periods may last up to two miles The patient is carried feet first unless in uphill or downhill carries he has a tendency to slide against an injured area If the terrain is rough care must be taken not to jostle him off It may even be necessary to strap him to the litter

Miscellaneous Carries Actually any means of transportation can be used for the injured that can be used by healthy people In remote places, if horses are available, they may be of great help If the patient is conscious, he may be lifted to the back of the horse and partially supported If he is seriously injured or is unconscious, it is more satisfactory to construct a *travois* This is a horse-drawn litter and may be constructed from two long poles, one end of each being attached like shafts to the side of the horse The other ends are permitted to drag upon the ground The poles are kept apart by crossbars, and the victim lies between them in a sling made by using blankets, ropes, canvas, or any other suitable material A litter may also be carried by using two bicycles in tandem (Petty, G F J Roy Army M Corps, 82-42 1944) One end of the stretcher is suspended to the transverse bar close under the saddle of the leading bicycle The rear end of the stretcher is attached to the transverse bar against the stearing column Where the bearers cannot ride, the bicycles can be pushed Rafts, punts and barges may easily be improvised and give very smooth transportation (Cormack, E H , and others J Roy Army M Corps 79-248, 1942) Sledge stretchers are especially designed for mountain casualties (Duff, D G Brit M J , 1 261, 1942) Baby buggy carriages, wheel barrows, in fact almost anything with wheels can be pressed into use

Transportation by Automobile If a regular ambulance is not available, one will have to resort to a truck or passenger car Improvised ambulances can be designed in advance from the usual panel trucks used to transport laundry, small packages and the like (Perry, E H Mil Surgeon, 91 693, 1942) They can be arranged to carry four litter wounded but can always carry two on the floor In an emergency, a mattress or similar bedding placed on the floor of such a truck is a better means of transportation than the passenger car Only a few of the seriously injured patients can be transported in an automobile without improvising some sort of bed Patients with wounds or fractures of the upper extremities can be transported in the sitting position in an automobile, although the driver must drive slowly and carefully avoiding bumps Patients with head injuries may be transported in a recumbent position in a sedan by placing them in the rear seat with their knees and hips flexed assuming the lower extremities pelvis or spine are not injured Someone must sit beside the patient particularly if he is not fully conscious A car in which the seats can be arranged to form a bed makes an ideal ambulance A station wagon is also an excellent substitute The back area is

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no patient fatalities (Broswell, L R World M J, 2 347, 1955) Special hospital planes have been designed not only to move the injured but also to treat them in part en route (Broswell, L R U S Armed Forces M J, 8 235, 1957) An Air Rescue Service has also been organized under command of MATS for local rescue work (Berry, C A J Aviation Med, 29 316, 1958) In the province of Saskatchewan the Air Ambulance Service has been in operation for over 10 years as an integral part of the routine transfer of patients to medical centers (Roemer, M I Canad M A J, 75 529, 1956) For years the Royal Australian Flying Doctors Service has brought in emergencies from the hinterland to the cities There are 350 air ambulances scattered throughout the United States registered with the Civil Aeronautics Commission and the Civil Air Patrol They will accept practically any type of patient on a physician s recommendation (Wright C C J A M A, 165 808, 1957) For all practical purposes any patient who can travel can fly The regular airlines, however, cannot accomodate a litter patient He must be able to help himself aboard be able to lie in a semireclining position and if very badly hurt must have an attendant If a person is injured badly in inaccessible country, the helicopter is the ideal means of transport Most of them are in government service, but a call to the nearest airport will be transmitted to higher echelons

too short for a patient to lie full length, but if he is placed upon a rigid litter, with the feet projecting through the opened back door, he can ride under supervision fairly well Litters can be loaded on a jeep or similar vehicle if they are securely anchored (Patterson, J K U S Nav M Bull, 41 1127, 1943)

Railway Train The railroad ambulance car which loads at the center and has a double row of beds along each side is an ideal means of shipping the sick and wounded for distances up to 300 miles They are available, however, only from military organizations It is difficult or almost impossible to use the ordinary coach or Pullman car to transport the injured A stretched-out litter patient cannot be loaded into a Pullman car except through a window (Harell, J Mil Surgeon, 90 689, 1942, Neff E B Mil Surgeon 92 542 1943) Only if the litter is short and narrow and the patient can assume a semisitting position is it possible to make the turns in the narrow passageways The latest type of Pullman cars have sealed windows and are useless for our purpose If railway transportation is available, the best improvisation is a series of cots or mattresses in a baggage car or freight car

Airplanes Mass evacuation of the wounded by plane was first used by the Germans in the Spanish Civil War (1936 to 1938) In World War II the United States transported by air over a million and a quarter patients Helicopter evacuation became an established means of transportation in the Korean War, in which during 31 months from January 1951 to August 1953, there were 17,698 patients evacuated by helicopter (Ned S J, Jr U S Armed Forces M J, 6 691, 1955) The future of helicopter evacuation in military as well as civil life can be surmised from an exercise in heli medical support for mass casualties carried out recently by the navy (Rohrs, L C, O Conner, T M, and *Addison J A U S Armed Forces M J, 9 241, 1958*) By the use of helicopters a 50 bed hospital unit with 97 personnel and 46,000 pounds of cargo was moved to land from a ship 2 000 yards off shore in three hours In one day 234 simulated casualties were treated and heli lifted back to the ship It is easily conceivable and very probable that mass civilian casualties will be carried directly from the first aid or collecting station to a neighboring airfield where fixed wing planes will take them to any part of the nation in a few hours time (White M S, and Merkle K W J A M A 153 20 1953) Since the Korean War a separate military unit, Military Air Transport Service (MATS) has been organized to transport military sick and injured from overseas During 1953 and 1954 it carried over 1,000,000 passengers and patients with three passenger and

principle of reaction It might be considered as a free flight projectile propelled by the reaction of its escaping gases

Missiles and rockets are further classified depending upon the site from which they are fired to the location of the target Broadly speaking five classifications of the missiles and rockets are recognized

1 Surface to surface
2 Surface to underwater
3 Surface to air
4 Air to surface
5 Air to air

Each of the Armed Forces has planned developed tested and put in operation a number of missiles A summary of the status of guided missiles and rockets by the Department of Defense, corrected to November 1959 is shown in the accompanying list

1 Surface to Surface

- ARMY MISSILES
  - Corporal (operational)
  - Redstone (operational)
  - Sergeant (under development)
  - Pershing (early development stage)
  - Jupiter (operational with the Air Force)
  - Lacrosse (operational)
- ARMY ROCKETS
  - Honest John (operational)
  - Little John (issued for training)
- NAVY MISSILES
  - Regulus I (operational)
  - Polaris (FBM) (advanced development stage)
  - Subroc (early development stage)
- AIR FORCE MISSILES
  - Snark (operational)
  - Atlas (operational)
  - Titan (under development)
  - Minuteman (in early development stage)
  - Thor (operational)
  - Matador (operational)
  - Mace (operational)
- MARINE CORPS MISSILE
  - Lacrosse (operational)
- MARINE CORPS ROCKETS
  - Honest John (operational)
  - Little John (issued for training)

2 Surface to Underwater

- NAVY ROCKETS
  - Weapons Able (operational)
  - Rat (soon to be operational)

3 Surface to Air

- ARMY MISSILES
  - Nike-Ajax (operational)
  - Nike-Hercules (operational)
  - Hawk (soon to be operational)
- NAVY MISSILES
  - Terrier (operational)
  - Talos (operational)
  - Tartar (soon to be operational)

4 Air to Surface

- NAVY MISSILES
  - Petrel (phased out of production)
  - Bullpup (operational)
  - Corvus (under development)
- NAVY ROCKET
  - Zuni (approved for fleet operational use)
- AIR FORCE MISSILES
  - Hound Dog (under development)
- MARINE CORPS MISSILE
  - Bullpup (in production)

5 Air to Air

- NAVY MISSILES
  - Sidewinder (operational)
  - Sparrow I (operational)
  - Sparrow II (developed for RCAF use)
  - Sparrow III (operational)
  - Eagle (in early development)
- NAVY ROCKET
  - Hvar (operational)
- AIR FORCE MISSILE
  - Falcon (operational)
- AIR FORCE ROCKET
  - Genie (operational)
- MARINE CORPS MISSILES
  - Sparrow I (operational)
  - Sparrow III (in production)
  - Sidewinder (operational)

10

Missiles, Rockets, Nuclear Bombs, and Other Forms of Attack

HAROLD C. LUETH

Developments in missiles and rocketry have drastically changed medical care in modern warfare. In June 1944, the Germans fired the first V-1 rockets or "buzz bombs" that had a relatively short range, small amounts of explosives in the warhead, and traveled at relatively slow speeds (about 400 miles per hour) against Britain. By September 6th of the same year, a larger, longer range, improved rocket, the V-2, made its appearance. From launching sites outside the Hague, Netherlands, 46 feet long V-2 rockets carrying a payload of 2,200 pounds of explosive and traveling at speeds of 3,500 m.p.h. reached the environs of London in less than six minutes. They caused considerable damage and inflicted numerous casualties and many deaths. About 1,500 V-2's were fired across the English Channel, of which 518 struck near London and 1,115 landed in England killing nearly 3,000 civilians and causing considerable property damage. Thus, the missile age and mass casualties were introduced in modern warfare.

MISSILES AND ROCKETS

During the decade remarkable progress has been made in the missile field and a whole family of weapons are either in the development period, testing stage, or are operational. A missile is defined as a weapon or object, such as a bullet or spear, designed to be thrown or shot.

Missiles are sometimes divided into ballistic missiles and nonballistic or guided missiles. A ballistic missile is defined as a missile whose course is determined primarily by its velocity at the end of thrust or ejection and the force of gravity. Guided missiles are missiles whose course can be corrected or altered while in flight.

Rockets are defined by Webster as a projectile consisting of a cylinder filled with a combustible substance which when ignited produces gases that escape through a vent in the rear and drive their container forward by the

bombs have less blast and heat effects (much of the energy is absorbed by the earth or water) and relatively higher localized or later windborne radiologic effects Subsurface bursts of the same yield weapon have lesser blast and heat effects and much higher induced radiation effects to either land or water These are general statements that could be modified by the type of weapon size terrain meteorology and other factors

CONVENTIONAL WEAPONS—ARTILLERY SHELLS AND BOMBS

Artillery shells or bombs are projectiles filled with some high explosive as TNT (trinitrotoluene) They are called conventional weapons because they are the principal weapons that have been used in aerial or artillery bombardment When a bomb explodes a rapid chemical reaction takes place and solids or liquids are converted into gas The newly formed gas exerts pressure in all directions in its effort to expand and the high pressures developed are called *blast effects* or simply *blast* Detonation and reaction follow so rapidly that shocklike pressures are developed Some heat is developed during the explosion but it is usually quite rapidly dissipated Most of the casualties from conventional weapons were from flying fragments There were some casualties and even a few deaths from blast

Bombs or shells filled with incendiaries caused numerous burns and deaths The fires generated by incendiaries caused burns or death to people trapped in buildings and whose escape was impeded or impossible

EFFECTS OF NUCLEAR WEAPONS

Early in the century physicists surmised that if atoms could be disintegrated, tremendous amounts of energy would be released On July 16, 1945 at Alamogordo Army Air Force Base, New Mexico the first successful detonation of an atomic weapon was accomplished Large amounts of energy were released through blast and heat, and a small amount of energy by radiation Since that time weapons have been made larger and much valuable information about the physical characteristics of the explosions gained From the early atom (fission) weapons, there have been developed thermonuclear (fission-fusion fission) weapons and TNT equivalents went from 20 KT to multi megatons (millions of tons of TNT) The medical problems have increased correspondingly in size type and duration

Three principal effects cause casualties—blast, heat and radiation

Blast Although blast shock resulting from bomb explosions was encountered in World War II it was not until the severe bombings of Britain that detailed study of the condition was made After bombing

Among the surface to surface weapons different types have been designed to meet the multiple specifications of target size composition, mobility and distance According to the range of the missile there are three groups short, medium and long range Short range surface to surface missiles have been designed to give close support to ground or naval forces and are of several types depending upon the characteristics desired e g SS-10 Lacrosse Medium range or intermediate range ballistic missiles (IRBM) have ranges from about 50 to 1 000 miles and include Jupiter (U S Army), Matador (U S Air Force), Regulus I (U S Navy) as examples Long range or intercontinental ballistic missiles (ICBM) have ranges of 1 500 to 5 000 miles examples include Atlas, Titan (U S Air Force) and Polaris (U S Navy) The Redston engine of Jupiter C was the first stage of the Explorer series of satellites projected into orbit by the U S Army Ballistic missiles have complex guidance systems that direct them to the target Rockets are free flight projectiles and follow the conventional trajectory or path of a shell after they leave their launching sites

NUCLEAR WEAPONS

The nuclear age began after the detonation of a nuclear aerial bomb over Hiroshima Japan in August 1945 An explosive force equivalent to 20 000 pounds of TNT was released instantaneously after the burst of the bomb It has been called a nominal A bomb or a 20 KT A bomb After an aerial burst of a 20 KT A bomb 2 000 feet above a city without warning and without sheltering nearly all persons within a radius of one half mile (880 yards) from the epicenter or the point on the ground immediately below the place where the bomb exploded would be killed instantly Within the second zone from one half mile to two miles (880 to 3 500 yards) there would be considerable damage to buildings with many casualties and deaths In the third zone from two miles to four miles (3 500 to 7 000 yards) epicenter structural damage would be less and there would be few casualties There would be little damage beyond four miles from ground zero

For planning purposes four rings are used starting from the center outward they are A ring complete destruction B ring severe damage C ring moderate damage and D ring light damage Beyond the D ring there are only sporadic injuries In the case of the 20 KT bomb the radii of the rings are at roughly one half mile intervals True circles are hypothetical and presuppose a flat terrain and the absence of wind Hills valleys or obstacles modify the forces of the explosion as do the winds both surface and at high altitude

Effects of nuclear or thermonuclear devices are dependent upon many factors such as size of weapon composition method of delivery terrain features, and meteorologic conditions Three general types of delivery are recognized aerial surface (either land or water) and subsurface (either land or water) Air bursts are defined as explosions in which no part of the fireball touches the surface Usually they are characterized by great blast and heat effects and relatively small radiologic effects Surface bursts of the same

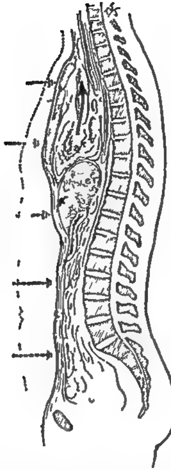

Fig 51 In blast shock the force will be inflicted particularly over the anterior portion of the body since the vertebral column acts somewhat as a protection Pulmonary injuries are most common but it can be readily understood that injuries to the intra abdominal organs and even the brain might be sustained In immersion blast intra abdominal injuries are of particular significance (From Cole Peace and War Orthopedic Surgery American Academy of Orthopedic Surgeons Edwards Brothers)

be essential By observing such victims for signs of pulse changes and other evidences of shock a serious collapse can usually be avoided Hot fluids containing mild stimulants such as coffee tea are indicated Cortical extracts (extract of the adrenal gland which to a great extent controls blood pressure) Levophed, and other agents should be helpful In severe cases transfusions and other intravenous fluids will be indicated

After a 20 KT nuclear explosion, winds of up to 600 miles per hour (blast waves) have been recorded near the epicenter of the explosion

raids it is not unusual to find dead bodies without any external evidence of injury At autopsy, tiny hemorrhages in the brain, lungs, adrenal glands, and other organs are found Diffuse hemorrhage into the alveoli of the lungs appears to be the chief injury Frequently, these injuries, trivial as they seem, are the only ones found The mechanism of their production and resultant death is poorly understood

When a bomb explodes, the bodies of individuals in the immediate vicinity are subjected to a *tremendous increase* in pressure which is transmitted to all parts of the body Even though the skull is not fractured, this pressure may be transmitted to the brain through the sudden pressure of soft parts against the spinal canal and by pressure exerted upward by way of the blood vessels The human body is not constructed to tolerate very marked increases in pressure, experiences in deep-sea diving have taught us that It appears obvious then that the sudden and severe increase in pressure may be sufficient to cause death even in the absence of crushing blows or injury sustained by flying missiles, the damage may be microscopic, but serious or fatal when occurring in vital centers

It must be emphasized that a great many individuals who survive a bombing raid may be suffering from blast shock (see Fig 51) Unfortunately, the symptoms are very insidious Such victims may or may not have been made unconscious by the explosion Commonly, they are found in a dazed, confused condition and, of course, with a variety of demonstrable wounds If external wounds are slight or absent, the seriousness of the patient s injury may not be appreciated Apparently, emotional imbalance is present in a great many of these victims, but after all a certain degree of temporary emotional instability following the terrors of a bombing raid would be expected in the average individual There may be little or no change in the blood pressure or pulse Examination of the urine may aid in detecting blast shock, since occasionally minute hemorrhage in the kidneys produces blood in the urine, the amount of blood may not be sufficient to show grossly but can be detected by microscopic or chemical examination Physical examination may be nonrevealing except for pallor and a confused state Yet the British have found that patients who have been subjected to bombing attacks tolerate operation (i e repair of lacerations etc) very poorly Even during very minor operations, they go into shock and die particularly if spinal anesthesia or a general anesthesia has been administered A local anesthesia (injection of procaine) is the anesthetic of choice Therefore they must be treated as being severely injured particularly if it is evident that they were near the spot when the bomb exploded Bed rest for a time may

Ahead of the blast wave there is a highly compressed moving wall of air called the shock front' that acts like a trip hammer Blast waves travel rapidly, faster than the speed of sound, from the epicenter and spread latterly in all directions Buildings, works of man, trees, and, if exposed, man himself will be subjected to these tremendous forces Amounts of pressure beyond normal atmospheric pressure generated are called over-pressures and are expressed in pounds per square inch, commonly abbreviated psi" Blast may be sufficient to knock down people who were standing, avulse extremities, rupture eardrums, cause fatal pulmonary or brain hemorrhage, etc The blast wave if unimpeded moves fairly fast and its intensity diminishes with time and distance Immediately behind the shock front, in time, a zone of rarefied air or suction develops after blast The number of people injured or killed by blast alone is quite small

More commonly blast is combined with its effects on buildings, structures, trees, etc (see Fig 52) Only one and a half psi (one and a half pounds more than atmospheric pressure) is needed to collapse an ordinary frame house, and some damage will be inflicted on buildings after one half psi blast waves The combination of shock front, dynamic drag, and suction after blast all act on objects after a nuclear detonation Shock front acts like a jet of highly compressed air under great pressure, behind this the rarefied air or suction after blast will cause windows to be sucked out, buildings to seemingly explode and the slower acting dynamic drag or the less rapidly moving wind wave will restore pressures to normal These effects cause considerable damage to buildings and other structures and many unprotected people will be injured or killed by flying missiles, trapped in buildings, buried under debris, etc Lacerations contusions, fractures and traumatic shock will constitute the bulk of the casualties Heat *and radiation if present will further complicate the situation*

IMMERSION BLAST The term immersion blast has been given to injury sustained by persons in water near an explosion Injury sustained by personnel near a bomb exploding underwater is more serious than a bomb of equal size exploding in the air, because the compressibility of air is greater than water thus tending to 'cushion' the force of the explosion the greater speed of the sound wave in water than in air also may be a factor Abdominal and thoracic cavities sustain the greatest injuries Viscera may be traumatized by the contusion incident to the blast and there may be numerous small or large hemorrhages and lacerations of variable degree Perforation of the intestine is fairly common Prominent symptoms are abdominal pain, pain in the chest hemoptysis (coughing of blood), and weakness Examination reveals marked tenderness in the

Fig 52 Dangers encountered during an aerial bombardment 1 demolition 2 blast 3 suction (after blast) 4 bomb fragments 5 debris from falling buildings etc 6 anti aircraft shell fragments 7 disabled aircraft and balloons 8 steel cables from destroyed captive barrage 10 gas

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abdomen with a variable amount of muscle spasm depending upon the severity of the blast and proximity to it

First aid treatment may not be very important from the standpoint of mortality rate, excepting that victims should be put on bed rest and should have *prophylactic treatment for shock* which may develop *Definitive treatment* will be much more important insofar as operation for perforation of an intestine may be necessary The administration of plasma plasma extenders, whole blood and/or other fluids is necessary and should be carried out as soon as possible Adequate morphine or pain relieving medicine should be given for pain since in many instances it is terrific

Heat. Nuclear bombs like conventional TNT bombs develop much destructive action through blast or shock They also are many times more powerful and have another different characteristic A large amount of the energy in a nuclear explosion is transmitted as light and heat The blinding flash of an atomic blast and the severe burning effects miles from its detonation are well known Often the light and heat are referred to as thermal radiation effects The dazzling brilliance of a nuclear detonation may cause some damage to the retina if a person attempts to look at it too long

The heat waves generated by the nuclear explosion reaching temperatures of those near the edge of the sun and rapidly spreading in all directions produce severe casualties An explosion is the sudden liberation of a great amount of energy in a relatively small space Conventional explosions like TNT follow the rearrangement of atoms in the substances used Nuclear detonations give much higher yields of energy due to the rearrangement and redistribution of protons and neutrons within the atomic nuclei The latter are accompanied by the liberation of tremendous amounts of thermal radiation In a conventional TNT explosion, nearly all of the energy is converted into blast and shock In a high air burst of a fission nuclear detonation (A bomb) about one half the energy is converted into blast and shock and one third into heat and light Almost instantaneously after a typical nuclear air burst a hot central mass is formed called the fireball It is roughly spherical and quickly grows in size and brilliance until it reaches a maximum After that it ascends and forms the picturesque mushroom shape with the fireball diminishing in brilliance and the upsurge of surface winds constituting the stem of the mushroom For example a 1 megaton air burst would have the fireball grow until it is nearly 5,800 feet (1 1 mile) across at maximum brilliance Temperatures of several million degrees are probably reached in the fireball The surrounding air is raised to temperatures of those of the sun

Thermal radiations will travel through the air quickly On a clear day the heat from a 1 megaton air burst will cause severe burns of the exposed skin as far as 12 miles away Actual warmth can be felt 75 miles from the explosion

BURNS Burns will constitute a large proportion of all casualties after nuclear or thermonuclear explosions In Hiroshima more than half of all casualties had burns Two types of burns are recognized

A Flash Burns Unprotected persons close to the bomb will sustain flash burns On August 6, 1945, at Hiroshima it was a very hot day and the people wore light clothing Consequently, there were many serious burns of exposed persons near the explosion Very high body surface temperatures were attained for a short time and resulted in burning large areas of exposed skin Clothing absorbed or reflected heat depending upon the nature and the color of the material Some protection was afforded those in the outer zones from the bomb who wore light loose clothing Heavy garments and tight-fitting apparel gave less protection Colored or black cloth absorbed heat and caused burns, while white clothing reflected the heat

Thermal radiation from an atom bomb to exposed portions of the skin resulted in almost immediate redness of the skin Japanese physicians reported that progressive darkening and blistering followed within a few hours the ultimate lesions depending upon the amount of exposure and depth of the burn Many persons injured by blast or trauma were unable to be evacuated and sustained fatal flash and flame burns Hair was often singed or burned to the roots At times ears were completely burned by flash burns It would be impossible to determine the degree of injury from burns, trauma and blast Plans must be made in advance of a nuclear attack to treat a very large number of burned patients within a very short period of time

Flash burns are treated as gasoline burns There are four important features in the emergency treatment of burns 1 relief of pain 2, application of an emergency dressing using aseptic technic, 3 treatment of shock using liberal quantities of whole blood and plasma as needed and 4 adjustments of water and salt requirements to maintain body fluids Antibiotic therapy and subsequent blood transfusions should be instituted as indicated to prevent or overcome infection, prevent shock and promote healing Advance planning must contemplate large numbers of casualties that will require the treatment just described and provision must be made for an adequate number of trained personnel equipment and supplies to provide treatment as soon after the attack as is possible

First degree burns may involve principally the face, neck, and hands They are usually very painful Prompt dressing of the burn by an ade quate dressing will do much to allay pain

If the burn is still painful, a non narcotic pain reliever (Darvon 65 mg) or barbiturates may be necessary Following this treatment, first degree burns if not infected should heal promptly without any complica tions

Second and third degree burns were seen in Japan and were more severe, often infected Careful attention to aseptic technic in dressing burn cases, prevention of shock, restoration of fluid and salt balance sedation as needed and the liberal use of whole blood, plasma, expanders as indicated, antibiotics, and skilled nursing care are essential in the proper treatment of extensive or deep flash burns Cleansing of burned areas with soap and sterile water, while desirable in civilian practice when sufficient time, skilled personnel and adequate material are available, will probably not be possible after an atomic attack with mass casualties await ing early treatment It is better not to attempt cleansing of the wound under conditions that will prevail after an atomic attack in the fear that more harm will be done than good accomplished The application of an adequate sterile dressing using aseptic technic and the closed dressing principle is desirable

Healing took place slowly among Japanese survivors after the atomic attacks, and often the sharply defined margins of the burns showed a loss of pigment as healing began Keloid formation after burns was probably the result of secondary infection of the burned areas Further details of the treatment of burns follow the description in Chapter 8

B Flame Burns There were probably not a large number of primary fires as the immediate result of the flash A number of secondary fires were caused by indirect blast effects causing building damage that carried hot and burning objects which kindled satellite fires The complete collapse of the fire fighting services and the lack of systematic evacuation of casualties from the bombed areas in Hiroshima and Nagasaki were responsible for many flame burns Even with adequate sheltering and prior training of personnel in civil defense, there will be many flame burns after an attack

Flame burns are treated as any other type of burn and follow the procedure described in Chapter 8

Radiation After the detonation of a nuclear device there is released a certain amount of energy in the form of nuclear energy Depending upon the type of the bomb and the surrounding materials a variety of effects

will occur For example, in a high aerial burst of certain types of bombs, 'clean bombs, the amount of residual radiation is relatively small and it will be dissipated in a relatively short time The same type of weapon that is detonated near the earth will induce radiation to the particles of earth In this latter case, there will be higher concentration of radiation over a much smaller area or zone Depending entirely upon the composition of the earth, there will be a different pattern of residual radiation for each major element or substance found in the earth In very large weapons —multimegation size—*the fireball may be so large that it touches the* earth and draws up large amounts of the earth and surrounding particles in the mushroom cloud These materials are made radioactive by nuclear energy within the bomb cloud Again, depending upon the size of the bomb the particle size of the earth's materials drawn into the bomb cloud and the wind pattern, there will be a variable course of these substances falling back to earth Fall out is the term applied to the return to earth of materials drawn into the fireball and made radioactive

Some idea of the extent of fall out might be gained from the data released after the very large thermonuclear device was tested at Bikini Atoll on March 1 1954 The explosion took place on a coral island and the fall out contaminated a cigar-shaped area approximately 220 statute miles downwind and of varying width up to 40 miles, with upwind and crosswind areas of possibly 20 miles from the point of detonation An area of about 7,000 square miles downwind from the burst was so contaminated that survival might have depended upon prompt evacuation of the area or upon taking prompt protective measures including shelter

The effects of nuclear radiation could be divided into immediate and residual In general, the radioactive particles that are generated and/or liberated immediately after a detonation are called immediate radiation effects' Usually the concomitant blast and heat are so serious that the immediate radiation is an additive effect The term delayed radiation usually means the residual or induced radiation either in a local area as ground or water, or more commonly fall out As was described above, the fireball in touching the earth s surface sweeps materials high into the stratosphere induces radiation and at the whim of the winds and depending upon the particle size falls to earth The widespread potentials of fall out of the larger weapons have made it a *terrifying hazard to the* uninformed and the unprotected

Shielding or shelter appears to be the only practical method of protection except evacuation Effects of shielding vary with the materials used and the type of construction Three feet of earth in a properly con-

structed shelter will reduce the effects of radiation by 1,000 times With these things in mind, a federal shelter program was announced on May 7, 1958

It has been estimated that 10 to 15 per cent of all injuries encountered in Japan after the atom bombs were the result of radiation One of the serious effects of nuclear fission is the release of ionizing radiation The effects of radiation of the atom bombs were similar to those produced by extensive or deep x-rays Experimental and clinical studies have shown that ionizing radiation affects different tissues and organs of the body differently The effects of radiation on the body depend upon (a) the amount of radiation absorbed, (b) the rate of absorption (c) the time over which radiation is applied, and (d) the surface of the body exposed Damage to the cells of the body is inflicted largely by *neutrons* invisible particles dispersed from the splitting of atoms, and *gamma rays*, invisible electromagnetic waves similar to x-rays that penetrate deeply into the body Unlike heat or other physical agents that produce sensory changes, these forms of energy cannot be felt or detected by the senses Cells are injured or killed by ionizing radiation as neutrons and gamma rays enter the complex chemical structure of the cells and disrupt them They produce marked changes in the proteins, nucleic acids, enzyme systems and other important biological processes If enough cells are severely damaged, the person is killed immediately, if fewer cells are damaged the patient may live for a time but be unable to regenerate cells and in time will die

a Amount of Atomic Radiation Absorbed The amount of radiation absorbed will largely influence the subsequent reaction of the exposed person Unless there is shielding either by design or accident persons exposed to radiation will absorb it While there is individual variation in the amount of radiation absorbed and variation in the symptomatology produced certain generalization is helpful Japanese who received 600 roentgens or more showed alarming symptoms Weakness lassitude and prostration occurred soon after exposure in three quarters of those subjected to these amounts of radiation A few died within 24 hours of the explosion of the atom bomb while others lived for ten days Nearly all who were exposed to 400 roentgens showed symptoms that were quite similar though there was considerable variability in the time of appearance of the various phases A typical clinical picture would include four phases

Phase A The patient becomes nauseated vomits feels weak and prostrated within an hour after exposure There may be diarrhea and some fall in blood pressure The clinical picture resembles that seen among patients treated extensively with x ray or radium and is much like radiation sickness

Phase B After the initial illness symptoms tend to disappear and the

patient feels better for the next few days or week The temporary abatement of symptoms will depend upon the amount of radiation received, there being a longer period of seeming improvement for smaller amounts of radiation and a shorter period for larger doses of radiation

Phase C Symptoms increase and the patient enters the critical phase The patient s ability to live through this period determines his ultimate course There is fever listlessness weakness tachycardia loss of appetite and nausea In severe cases there may be diarrhea (which is sometimes bloody), bleeding from the gums petechial hemorrhages in the skin and mucous membranes and fall in blood pressure Areas of mucous membranes may slough off leaving ulcers that may become secondarily infected Ulcerative stomatitis and lesions of the pharynx esophagus and intestines are very troublesome Epilation (falling out of hair) occurs about three weeks after exposure

Recovery depends upon the degree of injury and takes place early among those slightly injured The seriously injured are gravely ill for weeks and may get progressively worse for days until they die or may continue gravely ill for some time until healing and convalescence begin

Phase D The recovery period continues for some time often months with fatigue and weakness as prominent symptoms Skin hemorrhages disappear lesions of the gums and upper air passages heal the pulse rate returns to normal and new hair begins to grow in those areas where it fell out After six months a majority of patients feel well and laboratory tests indicate they have returned to normal

The amount of acute atomic radiation that the human body can sustain has been determined from isolated observations and the experiences encountered in Japan Animal experiments have been studied in detail and while there are species variations within each animal group there also are small individual variations therefore it is presumed that human beings react in a pattern similar to that observed among animals There are individual differences in human susceptibility to radiation and a summary of anticipated effects of acute radiation applied over the whole body is shown in Table 1

Table 1 Probable Early Effects of Acute Radiation Doses Over Whole Body

Acute Dose	Probable Effect
0–25r	No obvious injury
25–50r	Possible blood changes but no serious injury
50–100r	Blood cell changes some injury no disability
100–200r	Injury possible disability
200–400r	Injury and disability certain death possible
400–r	Fatal to 50 per cent
600r or more	Fatal

From *Effects of Atomic Weapons* Washington D C Combat Forces Press 1950

b Rate of Absorption Most biological activity is influenced by the rate of absorption of radiation In general there is less biological response to de

creased radiation exposure Genetic effects appear to be independent of the rate of absorption and depend on total radiation doses It is well known that man can tolerate poorly large doses of radiation given over a short period of time yet the same amount given over years might have no effect The atom bomb exposed large numbers of people to initial nuclear radiations over their whole bodies for a short period of time Clothing offers no protection against gamma radiation Casualties from nuclear explosions will show signs of acute radiation sickness Noncasualties exposed to radiation through fall out or otherwise will have to be screened for possible radiologic injuries

■ TIME OF RADIATION The exposure to nuclear radiation at both Hiroshima and Nagasaki was quite short After underwater detonations with considerable radioactive contamination of water and surrounding material personnel in the area may be exposed to radiation for long periods of time Prompt monitoring of suspected areas and early designation of safe regions will minimize the hazards of prolonged exposure to radioactivity

d RESULTS OF EXPOSURE Large doses of radiation to extensive areas of the body cause acute breakdown of the body tissues and affect certain organs more than others Various cells and tissues reach the height of destruction at different times after exposure so that no two organs or tissues suffer exactly the same amount of damage Lymphoid tissue bone marrow sex organs and mucous membranes are particularly susceptible and show great damage Skin liver and lungs are moderately affected by radiation while muscles nerve tissue and fully grown bone are least susceptible Only after heavy doses of radiation are cells killed immediately following lesser exposure the cells may not die for hours or days Often after moderate doses the skin may show only a surface reddening and swelling of the tissues and it may require several weeks until blistering and loss of dead skin is observed A summary of the clinical symptoms of radiation sickness is shown in Table 2

THE TREATMENT OF RADIATION CASUALTIES The treatment of nuclear radiation injury requires advance planning to insure adequate personnel and supplies to cope with the situation Immediate evacuation of all casualties from the bombed area to aid stations emergency treatment stations and hospitals is an essential first step in proper treatment Care must be exercised to avoid bringing patients or equipment contaminated by radioactivity into areas that serve as treatment centers All persons who received mild or moderate exposures (75 to 400r) should be put to rest at once to avoid fatigue They should be carefully guarded against exposure to cold and infection while they are being studied by clinical and laboratory methods Whole blood transfusions blood expanders adequate nutritional intake (supplemented if necessary by intravenous protein glucose, vitamin and other therapy) antibiotic therapy, and good nursing care are essentials in the treatment of radiation casualties

Table 2 Summary of Clinical Symptoms of Radiation Sickness

Time After Exposure	Lethal Dose (600r)	Median Lethal Dose (400r)	Moderate Dose (300–100r)
First week	Nausea and vomiting after 1–2 hours No definite symptoms	Nausea and vomiting after 1–2 hours No definite symptoms	No definite symptoms
Second week	Diarrhea Vomiting Inflammation of mouth and throat Fever Rapid emaciation Death (Mortality probably 100 per cent)	Beginning epilation Loss of appetite and general malaise	
Third week		Fever Severe inflammation of mouth and throat	Epilation Loss of appetite and general malaise
Fourth week		Pallor Petechiae diarrhea and nosebleeds Rapid emaciation Death (Mortality probably 20 per cent)	Sore throat Pallor Petechiae Diarrhea Moderate emaciation (Recovery likely unless complicated by poor previous health or superimposed injuries or infections)

From *Effects of Atomic Weapons* Washington D C Combat Forces Press 1950

CHEMICAL AGENTS

There are many chemical agents that could be used in warfare Gas is a popular name for that class of chemical agents that become volatile at ordinary temperatures The term chemical agents includes all those substances used for their toxic, irritating blinding, or blistering properties

Chemical agents are usually classified on the basis of their physiologic effects, however, other groupings on the basis of physical state, duration of activity, toxicity, and means of dispersion have been used A classification of chemical agents listing them in the order of physiologic reaction, in decreasing severity includes

1 Nerve gases
2 Blister gases—vesicants
3 Choking gases—lung irritants
4 Blood gases—systemic poisons
5 Vomiting gases—sternutators
6 Tear gases—lacrimators

It is important to know the type of chemical agent used as soon after its appearance is detected as possible so that proper protection and treatment can be instituted When the type of chemical agent employed is known personnel handling gas casualties can take steps to protect themselves against unnecessary contamination Rapid identification of chemical agents and the prompt transmission of this information to proper authorities is of great assistance in taking proper prophylaxis for all personnel In addition to the agents listed above, incendiary agents and screening agents will be discussed briefly later

1 **Nerve Gases** Nerve gases are some of the most deadly agents that could be used in chemical attacks They are colorless odorless tasteless gases that act by poisoning vital nerve synapsis like physostigmine and neostigmine Normally whenever muscles contract, acetylcholine is formed in the myoneural junction and an enzyme, cholinesterase breaks down the acetylcholine as it is formed Nerve gases act to prevent the enzyme cholinesterase from acting and acetylcholine accumulates in the nerve endings to such an extent that further action is stopped It occurs in the parasympathetic nerve endings that supply the smooth muscle action to the iris, ciliary body bronchial tree gastrointestinal tract urinary bladder, and blood vessels It also takes place in the secretory glands of the respiratory tract The sympathetic nerve endings to sweat glands are also involved Motor nerve endings to the voluntary muscles and nerves

to the autonomic ganglia are involved as is the central nervous system

Nerve gases are absorbed through any body surface, as the respiratory tract, gastrointestinal tract, skin, eyes When sufficiently large concentrations are absorbed, they cause general effects, and since they are readily absorbed, the systemic effects are seen rapidly The respiratory tract is the most rapid and efficient means of absorbing the gas and when exposed the effects are quickly apparent After exposure to sufficient concentrations of the gas, unprotected persons will die within 1 to 15 minutes They are quick killers It is important that the warning signs are immediately observed, the mask used, and treatment begun at once Early signs and symptoms of nerve gas poisoning include flushing of the face, pinpoint pupils (*miosis*), headache, dizziness, running nose (rhinorrhea), tightness of the chest wheezing or cough These are soon followed by severe headache, excessive salivation tightness and pain in the chest, nausea vomiting abdominal cramps, dimness and blurring of the vision, early fatigue and muscle weakness Dizziness pallor, extreme weakness drowsiness, cyanosis collapse, and death soon follow

PROPHYLAXIS Nerve gases are serious and lethal agents If there is reason to suspect the gas it is important to use the protective mask at once as the absorption of the nerve gas vapor by the respiratory system is rapid The mask should be worn until tests show there is no nerve gas in the air Atropine should not be administered as a prophylactic agent Clothing contaminated with liquid nerve gas should be handled by personnel equipped with protective masks protective gloves and protective clothing Contaminated clothing must be thoroughly washed using large amounts of water and if available alkali solutions

Treatment If any of the following are noted the protective mask must be put on at once

1 A feeling of tightness or constriction in the chest
2 Any difficulty in drawing a breath or in exhaling
3 Pinpoint pupils or dimness of vision
4 A drawing slightly painful sensation in the eyes

The mask must be worn as long as there are indications of the presence of nerve gas in the area

Atropine is a most effective treatment agent as it has the property of inhibiting the action of acetylcholine at all its many sites of action except in the voluntary muscles It is useful in the mild to moderately severe cases which do not include respiratory failure Artificial respiration and atropine must be used in cases of respiratory failure

Atropine may be given intramuscularly or intravenously by syrette Ampin or syringe or it may be given orally in tablet form Both the syrette

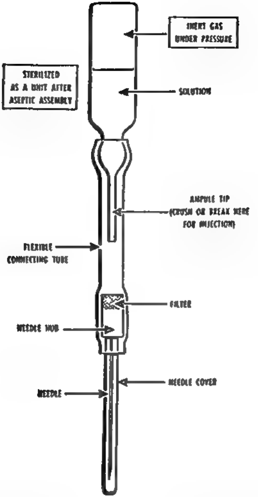

Fig 53 A type of automatic hypodermic injector (Ampin) particularly use ful for injection of antidote (atropine) for nerve gas poisoning (Courtesy of Strong Cobb & Co Inc)

and the Ampin (see Fig 53) contain 2 mg of atropine tartrate in solution (1 2 ml) If there are mild or moderate symptoms of nerve gas poisoning 2 mg of atropine should be injected intramuscularly at once If these symp toms are not relieved and if signs of atropine action (dry mouth and skin) do not appear atropine in 2 mg doses should be repeated at intervals of 10 minutes in moderate cases of poisoning or 20 minute intervals in mild cases of nerve gas poisoning Not more than three doses of atropine 6 mg should be given without the advice of a physician Casualties from nerve gas should not be permitted to smoke until all symptoms of nerve gas poisoning have dis appeared

Casualties with excessive bronchial secretions or salivation should be placed in a prone position and the foot of the litter or bed elevated The

upper air passage must be free the collar loosened the tongue pulled out dentures removed and the mouth and pharynx cleared periodically by suction using either a syringe or catheter

Artificial respiration must be used in all cases when breathing is impaired care first having been taken to insure a free airway With the cessation of respiration cyanosis and death will rapidly follow unless immediate steps are taken to overcome the condition Artificial respiration alone has little effect on the nerve gas poisoned patient who is not breathing The combination of atropine and artificial respiration will save many lives

If any liquid nerve gas is splashed into the eye immediate irrigation of the eye using large amounts of water must be done to prevent serious injury

2 Blister Gases Blister gases or vesicants are agents that cause severe blistering burning and actual destruction of the skin While strictly speaking they form a subgroup of irritants, just as do tear gases or vomiting gases, for convenience they are classed as a separate group Blister gases act in the eyes and skin damage the respiratory tract when inhaled and when absorbed they cause vomiting and diarrhea Nitrogen mustards and the arsenical vesicants (lewisite) are dangerous in this regard Blister gases include

a Mustard (H)
b Nitrogen mustards (HN)
c Lewisite (L)

a MUSTARD (H) Mustard is a heavy dark oily brown liquid that looks like crude coal tar and changes to a colorless gas after it is discharged from shells In weak concentrations the odor is that of garlic or horse radish while in stronger concentrations it has an irritating and pungent effect

Effects When exposed to mustard there is lacrimation and smarting of the eyes the skin becomes red itches and later blisters form which are thin walled and rupture easily leaving an open raw surface In some instances when the vesicles (blisters) are not ruptured they become infected and accumulate pus Folds of the skin that are warm and moist as under the armpits the groin the perineum tend to dissolve the chemical and produce severe burns with ulcers The eye is especially vulnerable to mustard and very small concentrations will affect it

b NITROGEN MUSTARD (HN) They are colorless to pale yellow solids or liquids that slowly vaporize and have a fishy or soaplike odor or at times are without odor

Effects The effects on the eye are similar to those seen after mustard except they appear in a shorter time Skin effects and effects on the respiratory tract are similar to those of mustard exposure however the gastrointestinal effects are more severe After swallowing substances contaminated by nitrogen mustard there is nausea vomiting gastrointestinal hemorrhage and diarrhea

Absorption of the arsenical blistering agent attacks the blood and lymph forming tissues Degenerative changes may be seen in the bone marrow within 12 hours after exposure and may progress The thymus spleen and lymph nodes are also attacked

■ LEWISITE (L) This is an arsenical vesicant colorless to brown liquid that vaporizes slowly has the odor of geraniums and causes severe blistering to the skin

Effects The effects of lewisite are similar to those of nitrogen mustard except the skin burns are more painful

TREATMENT The treament of blister gas casualties is quite similar and consists in very careful attention to small details Patients exposed to the mustards or lewisite must be separated at once from other casualties to reduce the possibility of further contamination If the clothing is contaminated it must be cut away, using care not to spread the agent to new skin areas Should some liquid vesicant still remain on the skin it can be blotted using clean absorbent dressings The skin then should be washed freely with water or a water soaked cloth to cleanse the skin Protective ointment M-5 used by the Armed Forces should then be spread liberally over the area When available solvents, such as gasoline (nonleaded), acetone carbon tetrachloride, alcohol, or oil should be used to dissolve the liquid mustard When solvents have been used, the parts should be washed with soap and warm water to cleanse the skin and reduce the irritation of the solvents Care must be taken in disposing of the clothes that were used in the treatment of the skin so as not to contaminate others No attempt should be made to salvage them, for they should be burned or buried

In cases of lewisite contamination of the skin BAL ointment, if available should be applied directly over the contaminated area This special ointment penetrates the skin and neutralizes the arsenicals in the deeper layers of the skin

Mustard burns of the eyes demand special attention If some vesicant is on the eyes it requires prompt treatment with BAL (British Anti-Lewisite) ophthalmic ointment The lower eyelid should be pulled down and some BAL eye ointment squeezed inside the lid Then the eyelids are closed and rubbed gently for one minute If the eyelids cannot be opened, apply BAL eye ointment to the lids and rub After that it will be possible to open the eyelids, after which the ointment can be applied inside the lower eyelids There probably will be some irritation from the eye ointment, which is to be expected After one minute s rubbing irrigate the eyes with clear water The stinging from the BAL eye ointment

will be relieved by the irrigations of water In the event BAL eye ointment is not available flush the eyes frequently with clear fresh water

After care of deep or serious vesicant burns is that described in Chapter 8 on burns

Lewisite and arsenical vesicants cause systemic poisoning from absorption through the skin or inhalation as vapor Marked changes in capillary permeability result with serious alterations in the fluid balance of the body, which may lead to death Treatment consists in the neutralization of the arsenical vesicant on the skin or within the skin by the application of BAL ointment In addition, systemic treatment with immediate *intramuscular injections of 10 percent BAL in oil deep in the* buttocks must be given Dosage varies with weight (0 1 ml per 5 pounds of body weight) For example a 150 pound man would receive 3 0 ml The same dose is repeated 4 8, and 12 hours after the initial injection There may be some slight reactions to the BAL injections that last 15 to 30 minutes

3 Choking Gases Choking gases or lung irritants include those chemical agents that produce pulmonary edema Two best known are

a PHOSGENE (CG) A colorless gas that has an odor like freshly cut hay is nonpersistent and effective for 5 to 20 minutes

b CYANOGEN CHLORIDE (CK) A colorless liquid with a very irritating odor In exposed personnel there is coughing choking tightness in the chest nausea and vomiting The most startling and serious effect of lung irritants is the changes it induces in the lungs e g swelling of the alveoli and pouring of fluid in the air sacs of the lungs Mucous membranes become swollen to such an extent that they become boggy and with the fluid in the alveoli blood passing through the lungs has difficulty in getting enough oxygen There may be an interval of 2 to 24 hours after exposure before abnormal chest signs develop Pulmonary edema begins rapidly with shallow quick breathing painful cough and cyanosis As the condition progresses dyspnea increases rales and rhonchi are heard and the patient develops shock wet clammy skin feeble heart action and low blood pressure which may lead to death

Treatment The treatment of all personnel exposed to choking gas consists in the immediate removal from the contaminated area close observation and when indicated complete rest and supportive treatment The appearance of respiratory distress is the indication that the casualty should be given complete rest and evacuated Initial symptoms do not indicate the severity of the condition Supportive treatment consists in the judicious use of oxygen sedation and maintaining fluid balance For details of oxygen administration see Chapter 13 It is desirable to use high concentrations of oxygen initially to overcome cough dyspnea, restlessness and cyanosis For longer periods of administration lower concentrations of oxygen should be used Sedatives must be used judiciously Only if oxygen fails to quiet the patient should codeine 32 to 64 mg or more rarely morphine 10 to 15 mg be used The newer nonbarbiturate chemicals as Placidyl or Valmid might be tried

Summary of Chemical

Chemical Warfare Agent	Odor	Respiratory Tract	Skin
Nerve gases	None or faint sweetishness fruity	Tightness in chest occasional wheezing increased bronchial secretion cough dyspnea pulmonary edema cyanosis	Sweating
Mustard (H) and Nitrogen mustard (HN)	Garlic or horse radish irritating / None or fishy irritating	Slowly developing irritation hoarseness aphonia cough tightness dyspnea rales pneumonia fever	Redness burning blisters surrounded by redness itching necrosis later if exposure marked
Lewisite (L) and other arsenical vesicants	Fruity to geraniumlike very irritating	Like H and HN but local pain and irritation more prompt and more severe	
Phosgene (CG)	Green corn new mown hay	Prompt coughing choking tightness in chest later pulmonary edema, with dyspnea, painful cough cyanosis frothy sputum rales pneumonia fever	
Hydrocyanic acid (AC)	Faint bitter almonds	Deep respiration followed rapidly by dyspnea, gasping and then cessation of respiration	Pinker than normal
Cyanogen chloride (CK)	Very irritating	*Irritation cough choking* tightness dyspnea later pulmonary edema	*Like AC*
Sternutators (nose gases) adamsite etc (DM DA DC)	Burning fire works very irritating	Tightness and pain uncontrollable coughing	Stinging, espec of face occasional dermatitis
Lacrimators (tear gas) (CN CNC BBC)	Irritating	Tightness and irritation if concentration high	Stinging espec of face occasional dermatitis

Warfare Agents*

G I Tract	Central Nervous System	Treatment
Salivation anorexia nausea vomiting abdominal cramps substernal tightness Heartburn eructation diarrhea tenesmus involuntary defecation	Giddiness tension insomnia headache drowsiness difficulty concentrating poor memory confusion slurred speech ataxia weakness coma with areflexia Cheyne Stokes respirations convulsions	Atropine I M or I V and conjunctivally artificial respiration and oxygen
Pain, nausea vomiting diarrhea	Malaise prostration depression after severe symptoms	For eyes analgesics antibiotics and local atropine For skin local dressings and systemic antibiotics For respiratory tract antibiotics For G I symptoms sedatives If shock occurs I V fluids or transfusions
Like H and HN but local pain and irritation more prompt and more severe	Like H and HN	Like above also BAL ointment to skin and intramuscular BAL in oil
Nausea occasional vomiting (after respiratory symptoms)	Like H and HN also headache	Rest oxygen antibiotics
Nausea	Giddiness headache coma convulsions later irrational behavior ataxia	Amyl nitrite inhalation sodium nitrate and sodium thiosulfate I V artificial respiration
Like AC	Like AC	Like AC
Salivation nausea vomiting	Headache mental depression	Wear mask in spite of symptoms spontaneous improvement is rapid chloroform inhalation gives symptomatic relief
Occasional vomiting	Headache	Spontaneous improvement rapid analgesic eye and nose drops if necessary

* Adapted from Department of the Army Technical Manual 8–285 Treatment of Chemical Warfare Casualties December 1956

4 Blood Gases Systemic poisons or blood gases produce their effects by interfering with the vital oxidative processes of the body Hydrocyanic acid combines with the vital enzyme cytochrome oxidase, which prevents oxygen from leaving the tissues There are two agents in this group

a HYDROCYANIC ACID (AC) A colorless light liquid that has a faint odor like peach kernels or bitter almonds
b CYANOGEN CHLORIDE (CK) See 3b above

Hydrocyanic acid is a very toxic agent and either death occurs rapidly or recovery takes place within a few minutes after removal from the contaminated area Exposed personnel in areas of high concentration note an increase in respiration within a few seconds violent convulsions after 20 to 30 seconds cessation of respiration and death within a few minutes after exposure

Treatment Amyl nitrite held under the nose of the patient is the first step in emergency treatment after the casualty is removed from the area This should be repeated as necessary If breathing has ceased artificial respiration should be administered until spontaneous breathing resumes or at least 10 minutes after all cardiac action has ceased If the patient cannot be evacuated the protective mask must be put on and the amyl nitrite given inside the mask. Artificial respiration also must be given with the mask on the patient

5 Vomiting Gases Sternutators, or nose gases or irritant smokes are solids that are burned as smokes and produce severe irritation of the upper respiratory tract causing coughing sneezing, nausea, vomiting, and a general feeling of malaise After exposure in unprotected persons, there will be sneezing coughing nausea and vomiting The protective mask assures adequate safety and freedom from these agents Casualties should be removed from the danger area at once and given plenty of fresh air When it is not possible to evacuate the casualty the protective mask must be put on him

6 Tear Gases Lacrimators or tear gases are those mixtures that cause an exposed person to break out in a flood of tears, have a warm prickly sensation about the face and neck and in rare cases have headache nausea or vomiting Treatment consists in removing the patient from the danger area to fresh air

There are two other classes of chemical agents that may be employed and could cause some casualties

7 Incendiary Substances Incendiaries are chemical agents that cause destruction by means of their rapid burning They oxidize quickly generating large amounts of heat and are hazardous in their potential ability to destroy all flammable material in the vicinity Fragments from sputter-

ing incendiary bombs cause deep troublesome burns in affected personnel

Incendiaries are highly combustible substances that cause considerable damage by the fires they originate *Thermite* (TH), a mixture of ferric oxide and powdered aluminium burns at a temperature of 4,330° F At times molten bits of metal may cause serious burns More commonly, severe burns follow inexpert attempts at extinguishing thermite fires

Magnesium burns at about 3,630° F with a scattering effect like thermite, and white phosphorus (WP) burns emitting a white smoke In rare instances, some burning particles of white phosphorus may become embedded in a person s skin and severe burns follow Since white phosphorus will burn while exposed to air, cover the particles with water as quickly as possible and attempt to remove the burning particles If available, cover the white phosphorus particles with a 5 percent copper sulfate solution until they are removed Combustible hydrocarbon incendiaries such as napalm, may produce burns Treat the burns as indicated in Chapter 8

8 **Screening Smokes** Chemical agents which when burned leave small particles suspended in the air for a reasonable length of time are called screening smokes They are used in military operations to conceal activity or movement Five principal agents are used petroleum oils, HC mixture (essentially a zinc chloride smoke) sulfur trioxide-chlorosulfuric acid (FS), titanium tetrachloride (FM) and white phosphorus (WP) They are of little medical interest except for the burns they might inflict

THE PROTECTIVE MASK

Complete respiratory protection against all known military chemical agents can be afforded by the protective mask There are three main parts to the conventional protective mask the facepiece assembly, the canister and the carrying device Most masks are so constructed that they can be folded into compact packages that are easily carried

The facepiece is made of either impregnated molded rubber such as the Armed Services masks, or laminated impervious fabrics or material as in the civilian masks They are made in several different types to fit the contours of the head and face and thus insure a secure air-seal In addition there are eyepieces made of plastic or glass which are fitted snugly to the facepiece A head harness is required to keep the mask in place

The heart of the mask is the canister, which purifies chemically polluted air making it safe for human respiration There are two main parts to the canister—a mechanical filter and a chemical filter Depending upon

Fig 53A The civilian protective mask developed for the Office of Civil and Defense Mobilization is a radical departure from conventional mask types in that a special filtering material (combined gas aerosol filter media) serves as the major portion of the facepiece The mask periphery and harness tabs are injection molded of vinyl plastic It is anticipated that this mask will be used in civil defense operations and will be worn with protective clothing (Courtesy of the Department of Defense)

the types of filters protective masks can be constructed so as to protect against any known chemical agent While the person must draw air through the filter systems to purify air he must also exhale it through the mask This latter is accomplished by means of an ingenious flutter valve The protective mask does not furnish oxygen Masks in current use in the Armed Services do not protect against carbon monoxide and ammonia

A carrying device is a simple and easy means of transporting the protective mask and having it available for instantaneous wear and use

BIOLOGICAL AGENTS

A number of biological agents have been mentioned as possible enemy threats They include bacteria, rickettsia, fungi, viruses, toxins, and other biological products Attacks may be directed against man animals or plants Detection and recognition become important aspects in the prevention and treatment of these biological threats Proper steps in prevention and treatment will be those used in connection with the specific condition encountered

MASS CASUALTY CARE

The advent of nuclear weapons and other mass casualty producing agents has tremendously complicated the problem of medical care In all studies of probable event after mass casualties it is apparent that there will be a great disparity between the medical means available and the medical service required Present methods of handling casualties will be totally ineffective Medical personnel, supplies, equipment and facilities will have to be used in such a manner as to provide the greatest good for the largest number Any procedure or operation undertaken must make patients more able to care for themselves, since anything done to make the patient less able to look after his own needs simply adds further medical service burdens to the already staggering load

Casualties in numbers not encountered in the past and inflicted in a very short period of time will pose tremendous problems in first aid Since medically trained personnel will have to thoughtfully ration their time and efforts to the more seriously injured there is need that each citizen will have to be trained in first aid

A First Aid Under present conditions each person must be trained in first aid so that he will be able to do those life and limb saving procedures that will save his life his family s lives and his neighbors' lives Among the more important things that he should be able to do are

1 Application of dressings to wounds burns etc
2 Application of pressure dressings to control hemorrhage
3 Emergency splinting of fractures of the extremities
4 Proper handling and evacuation of the injured
5 Maintenance of patent upper airways
6 Administration of artificial respiration
7 Emergency care of certain wounds for example hand injuries, jaw injuries, sucking chest wounds

Significant steps in this direction have been taken by the Army in training all personnel in the elements of first aid and lifesaving procedures Through self-help and 'buddy help' many lives can be saved An ex tensive program for teaching the general public is under study

B Sorting Proper sorting is the key to effective mass casualty care The Army Medical Service has made an extensive study of the problem and many of the following recommendations are taken from their find ings To provide the greatest good to the largest number of patients some concepts of medical service not practiced in peacetime civil medical practice will have to be adopted Patients will be examined and sorted on the basis of the type and urgency of their condition so that they can be sent to an area or medical facility equipped for their care It simply means that patients will be grouped according to the seriousness and kind of injury, the likelihood of survival, and the establishment of a priority system to assure the greatest good to the largest number Using this system it will be possible to have an orderly and efficient use of medical personnel supplies, and facilities Slightly injured will be sepa rated from the casualty stream They will be sent to areas for self help and buddy help' This procedure alone will reduce the casualty load considerably Also those treated who can possibly care for themselves will have to look after themselves and probably others can buddy help

Sorting must be continuous throughout the medical care operation to insure the timeliness orderliness, and effectiveness of the limited medi cal facilities available to the large number of casualties The categories described in TB MED 246 Early Medical Management of Mass Casual ties in Nuclear Warfare should be used They include

a MINIMAL Those patients who can be returned to useful work immedi ately and include small lacerations and contusions simple fractures of the small bones of the upper extremity second degree burns that involve 10 per cent or less of the body and do not include the face or hands mild neuropsy chiatric disorders etc Later there will be a group of patients who will not be able to be effective workers and who need some assistance in meeting their daily needs Included in this group are those patients with secondary degree burns of the face that interfere with sight or eating incapacitating burns of both hands disabling fractures of minor bones or moderate neuropsychiatric disorders

b IMMEDIATE TREATMENT Patients whose conditions are so urgent that expedient treatment will save life or limb are classed under immediate treat ment They include patients with hemorrhage from an easily accessible site extensive lacerations rapidly correctable mechanical respiratory defects se

vere crushing injuries of the extremities open fractures of the long bones, and incomplete amputations

c Delayed Treatment There are a group of patients who after emergency care incur little increased risk by delay in further treatment such as patients with moderate lacerations without extensive hemorrhage closed fractures of major bones and noncritical injuries of the central nervous system

d Expectant Treatment Finally there is a group of patients so critically injured that even complicated and prolonged treatment offers no hope for improving life expectancy These include patients with critical injuries to the respiratory or central nervous systems significant penetrating abdominal wounds multiple severe injuries and severe burns of large areas of the body (in excess of 40 per cent)

C Proportion of Casualties For planning purposes, the following figures have been used It should be remembered that there may be considerable variation from these figures in casualties found after disaster or nuclear attack

Minimal Treatment	40 per cent
Immediate Treatment	20 per cent
Delayed Treatment	20 per cent
Expectant Treatment	20 per cent

D Emergency Treatment During the first few days after a nuclear attack there probably will be little care given by medical personnel, except those measures directed to saving life and limb Every effort will be made to restore the injured person to a useful state to preserve his life and to increase his self sustaining capabilities Only emergency medical care will be given in the immediate post impact period of 60 to 72 hours after the attack Definitive treatment must be deferred during this period No treatment should be started or undertaken that will make an injured person less able to care for himself or which will jeopardize his probabilities for later more effective care

Emergency treatment is limited to resuscitation and essential surgical procedures

1 Resuscitation The principal element of resuscitative treatment will be the overcoming of shock after trauma Where possible, oral fluids should be used or they should be used in addition to intravenous fluids Patients with hemorrhage that has been controlled or severe burn cases should receive priority care Shock will be treated as described in Chapter 6

2 Essential Surgery Ligation of major vessels, tracheostomy, simple closure of sucking chest wounds with dressings, and relief of tension pneumothorax are some of the procedures included in essential surgery

E Definitive Surgery Depending upon the availability of time, personnel, supplies and equipment, recognized surgical operations and definitive surgery will be done

NATIONAL CIVIL DEFENSE

Since World War II there has been continuous planning for the civil defense of the nation Changes in weapons systems, weapon delivery means, and other factors have made it necessary to continuously review plans and make suitable provision for current developments In December 1958, President Eisenhower announced a national civil defense plan for the country

The plan defines the mission of each level of government including the duties and obligations of each citizen It gives the channels of action and coordination and in broad terms describes the functions to be performed by citizens and each level of government The plan is a broad directive that projects the nonmilitary defense of the nation ten years in the future anticipating probable developments in the weapon and delivery systems Major elements in the basic plan are described in greater detail in the more than 41 operational annexes, some of which have been completed and others such as The National Shelter Plan, The National Medical and Health Plan, The National Radiological Defense Plan, are being prepared

Following the completion of the state survival studies and with the passage of Public Law 606 85th Congress, there has been a change in the operation of civil defense Formerly, each state was an operating unit and the Federal Government played a coordinating role Under the new law, the Federal Government is a co equal partner with the state and will exercise guidance in planning training and operating for civil defense The results of the state survival studies incorporate recent estimates and present concepts of nonmilitary defense Each state plan is being critically reviewed and redrafted in the light of these new developments Also the merger of Federal Civil Defense Administration and Office of Defense Mobilization in 1958 into the Office of Civil and Defense Mobilization (OCDM) has reduced much confusion some duplication, and uncertainty of the past

The proposed delegations of medical and health matters by the OCDM to the United States Public Health Service is expected to be approved in the near future Until this is accomplished, it will not be possible to exactly define the medical and health policies

Medical and health services during and after disaster, either natural or enemy induced, may be broadly considered under three headings

A Emergency Medical Services
B Special Weapons Defense Services
C Preventive Medical Services

There will be some variation of organizational and functional concepts in the different states and communities, however, the three headings comprise major missions

A Emergency Medical Services The term 'emergency medical services includes all medical services and care that must be furnished during and after disaster In the past the term casualty services was used, however, larger weapons greater areas of destruction, and the planned and unplanned dispersal of people will require care for both casualties and noncasualties

1 Casualty Care (See Fig 54) Under the current concept there are four echelons of medical service in civil defense operations

(a) *Individual* Each individual citizen must be able to give the essential life and limb saving care to himself, his family, and his neighbor

(b) *First Aid Station* First aid stations will be set up in such a manner as to be able to treat 500 casualties in the first eight hours of operation and 1,000 casualties in the first 24 hours of operation For planning purposes, about 12 standard first aid stations are allocated for each 100 000 population in target areas A first aid station consists of four groups field first aid litter bearer, ambulance and first aid station The personnel are shown in Figure 55

It is suggested that not less than 1 800 square feet of floor working space be available for a fixed first aid station Adequate doors water sewage facilities utilities heat etc should if possible be available Detailed information is given in Federal Civil Defense Administration, TM 11 1 Organization and Operation of Civil Defense Casualty Service (see Fig 56)

Introduction of multimegaton weapons has led some planners to revise their thinking and suggestions have been made to use an Emergency Treatment Station (ETS) at the periphery of the damaged zones Under

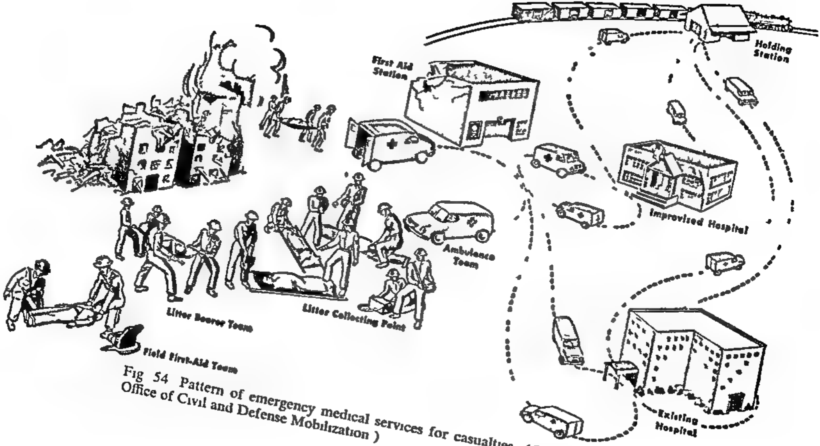

Fig 54 Pattern of emergency medical services for casualties (Courtesy of Office of Civil and Defense Mobilization)

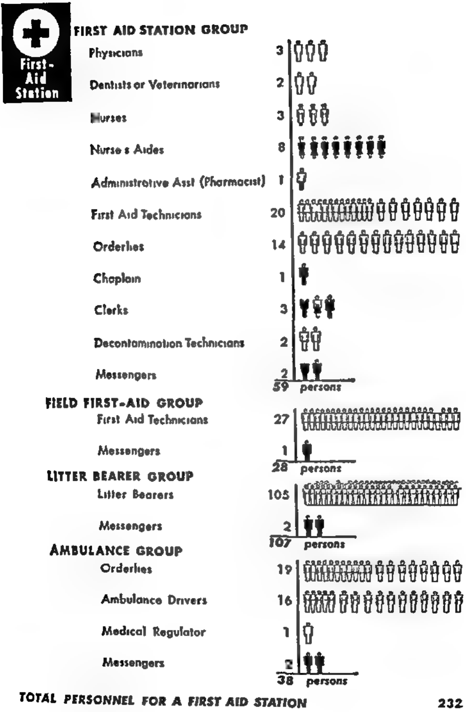

Fig 55 Personnel for a first aid station (Courtesy of Office of Civil and Defense Mobilization)

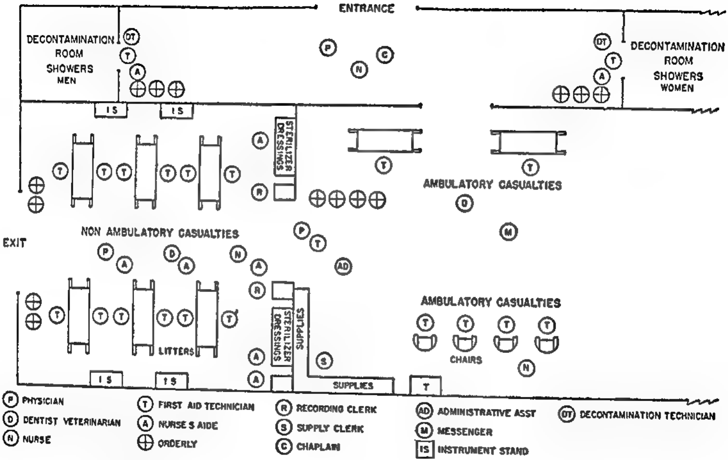

Fig 56 Sample first aid station layout (Courtesy of Office of Civil and Defense Mobilization)

this concept, which has not been officially adopted, there would be a considerable augmentation of the personnel, supplies, and equipment of the first aid station to make it an emergency treatment station Life and limb saving procedures could be performed at the ETS

(c) *200 Bed Civil Defense Emergency Hospital* This is a mobile hospital capable of doing resuscitation, emergency medical and surgical services, and if necessary definitive surgery It is mobile in the sense that it can be moved from its point of storage to its site of operation Not less than 20,000 square feet of floor space is needed for a 200 bed CD emergency hospital It is an adaptation and enlargement of the 60 bed MASH hospital used so effectively by the U S Army in Korea There are more than 400 pieces comprising 290 items in the 200-bed CD emergency hospital The hospital assembly weighs more than 13 tons and has a cube of 1,800 Basic functional units of the hospital are

1 Triage unit
2 Wards (totaling 200 beds)
3 Three operating room units
4 Sterilizing unit
5 X-ray unit
6 Pharmacy
7 Clinical laboratory
8 Central supply

A 15 KV generator as an auxiliary power source and a 1,500 gallon water tank and pumping unit for emergency water supply are parts of the hospital assembly

The 200-bed CD emergency hospital is equipped for emergency and definitive surgery Studies have been made on the supply and equipment lists and they are under constant revision to insure potential capabilities for good medical care Augmentation units have been proposed from time to time that would permit the hospital to assume specialized care, such as eye, ear nose and throat surgery, thoracic surgery, neurosurgery, obstetrics and gynecology genitourinary surgery and medical emergency care

(d) *Existing Hospital* Each existing hospital has been requested to make plans to triple its bed capacity and be able to operate under disaster conditions Individual hospitals are responsible for meeting the requirements of both natural disaster and enemy action

2 NONCASUALTY CARE Plans are under consideration for the provision of noncasualty care e g , delivery of newborn, pediatric, medical, surgical care, to the surviving population

B Special Weapons Defense Services Steps have been taken to develop special medical and health services for the planning training and operating of services that will provide defense against chemical, biological, radiologic, and other special weapons

C Preventive Medical Services Not only will the normal measure of preventive medical service continue but under the impact of enemy action an augmented and strengthened preventive medical service will be required Displacement of personnel, disruption of normal safeguards of sanitation limited supplies and equipment, and mass casualty care loads are some of the features that make an effective preventive medical service an essential requirement before, during and after disaster

BIBLIOGRAPHY

United States Civil Defense
Federal Civil Defense Administration
TM 11-1 Organization and Operation of Civil Defense Casualty Services Part 1—The First Aid System 1953
TM 11-3 Organization and Operation of Civil Defense Casualty Services Part III—Medical Records for Casualties March 1952
TM 11-7 The Nurse in Civil Defense (Revised Edition) 1954
TM 11-8 Emergency Medical Treatment April 1953
TM 11-9 The Dentist in Civil Defense (Revised) April 1954
TM 11-10 Civil Defense Against Biological Warfare Nov 1953
TM 11-11 The Veterinarian in Civil Defense Jan 1955
AG 11-1 Health and Special Weapons Defense Dec 1950
Dept of the Army Pamphlet No 39-2
The Effects of High Yield Nuclear Explosions A Report by the United States Atomic Energy Commission June 1955
Dept of the Army Technical Bulletin TB MED 246
Early Management of Mass Casualties in Nuclear Warfare 12 Oct 1955 Also NAVMED P-5046 and AFP 160-2-4
Dept of the Army Technical Manual TM 8-285
Treatment of Chemical Warfare Casualties Dec 1956 Also NAVMED P-5041 and AFM 160-12
Office of Civil and Defense Mobilization MP-7
What you should know about the National Plan for Civil Defense and Defense Mobilization Dec 1958

11

Fractures, Dislocations, and Sprains

FRED W. HARK

FRACTURES

A fracture is a dissolution of the supporting structure of the body; it is commonly thought of as being a break in the bony part of the skeleton. In the majority of injuries the fracturing force causes more or less damage to the tissues near the bone before its force is spent. A light blow on the thigh may cause only a bruising of the skin and muscles, which may not even be visible. A similar blow but with greater intensity may set up enough vibratory displacement to cause a fracture of a femur before it is spent. In addition to the direct damage caused by this pathologic rebound of the fractured ends of the bone, this false motion tears a certain amount of muscle tissue or whatever tissue may be in its path. If a nerve lies next to the bone it may become caught between the ends as they spring back into proximity to each other (see Fig. 102). If the nerve does not have enough slack it will be torn. This not infrequently happens in fractures or more strictly speaking, fracture dislocations of the spine. Any severe trauma to the spine, including even acute flexion, may damage the vertebrae and spinal cord. Pain in the back accompanied by paralysis of the lower extremities with anesthesia of the skin following an accident is fairly diagnostic of injury to the spinal cord. At the hospital the x rays may show the individual vertebrae to be in perfect alignment with respect to each other. One may wonder how the cord could be damaged. The abnormal force shifted one or more vertebrae so far away from the normal position that the cord was crushed or sheared off either during the act of displacement or during the rebound. Similar irreparable damage can be inflicted by careless but well intentioned first aid work.

Classification of Fractures. Fractures are classified in many ways; one important classification is dependent upon whether or not there is an opening through the skin. If there is an opening through the skin and intervening tissues to the bone, the fracture is spoken of as being *com-*

pound or open If the skin is not broken it is known as a *simple or closed fracture* It is not always easy to make a proper distinction The fracturing or accidental force may break the skin but the muscles are intact, hence there is no communication of the bone with the outside world and it is a simple fracture associated with a superficial wound Then again the sharp bone ends may cut the muscle badly either at the time of fracture or during careless handling on the part of the surgeon or first aid attendant Even though there is a hole in the muscles it is still a simple fracture since the skin is intact If there are more than two pieces in the fracture it is known as a *comminuted fracture* that is, there is more than one fracture line (see Fig 57), free pieces of bone (perhaps many) may be present at the fracture site Then again, fractures are classified according to the direction of the line of break If it is at right angles to the shaft of the bone, it is a *transverse fracture* (see Fig 58), if it is at an acute angle with the shaft it is an *oblique fracture* If the fracture line changes its direction frequently after the fashion of a spring it is known as a *spiral fracture* Then again fractures are complete or incomplete An incomplete fracture is known as a *greenstick fracture* A buckling fracture is a type of incomplete fracture An *impacted fracture* is one in which the broken ends are jammed so tightly together one against the other, that at least part of the supporting strength of the bone is maintained

A bone may become broken in one of three ways

1 *Direct violence* The bone is broken at the site of the blow
2 *Indirect violence* The blow is received at a distance from the break usually in the line of the bone as falling on the hand and getting a forearm bone break, a foot caught and twisted may cause a leg bone fracture
3 *By powerful muscular contraction* A bone or piece of bone may be broken by the force of a contracting muscle Pieces are pulled from the pelvic bones by the pull of muscles The knee-cap is not infrequently broken in this way

Fractures have been observed and described in every bone in the body They are becoming more numerous because of the automobile and other power machines There are characteristic fractures of the upper end of the tibia known as *bumper fractures* (see Fig 63) Bumpers of cars strike one just below the knee joint causing fracture of the tuberosities of the tibia A certain type of fracture of the hip socket is known as a *dashboard fracture* In World War II there were fractures about the ankle of a characteristic pattern which might be called explosion frac

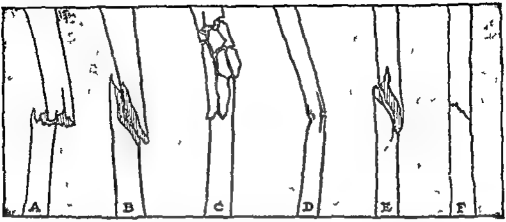

Fig 57 A transverse fracture with moderate displacement B oblique fracture C comminuted fracture D greenstick fracture E, spiral fracture F fissure fracture

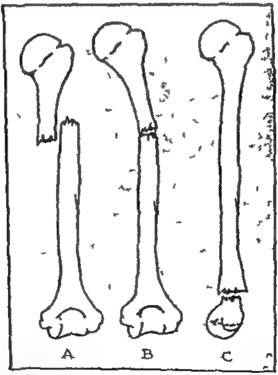

Fig 58 A transverse fracture with displacement and overriding B transverse fracture with angulation at fracture site C transverse fracture with 90° rotation of distal fragment

tures, a bomb bursting in or under a boat raises the deck and drives the foot into the tibia, causing a characteristic shattering fracture

The site and type of a fracture is also determined by the characteristics of the bone itself The clavicle or collar bone breaks at the junction of the outer third with the inner two thirds because there is a torsion of one end of the bone on the other of about 90° at this site, which therefore is the weakest part of the bone Also the shoulder blade (scapula) and the collar bone (clavicle) are anchored to each other by a ligament known as the coracoclavicular ligament This creates stress by giving the fracture force a greater leverage

Manifestations of Fractures The signs of a fracture are not always present Many times when one suspects a fracture the suspicion is not verified Then again when not suspecting one it does exist and the treatment is not adequate All symptoms of a fracture are not present in every fracture Sometimes the patient feels the bone break or hears it snap 1 *Pain and tenderness* are present at the site of the break 2 There is usually *loss of use* (*disability*) of the extremity containing the break Disability may be very useful in determining the presence of a fracture For example any person who has suffered such a severe injury to his leg that he cannot walk should be considered as having a fracture until proven otherwise On the other hand, when a fracture is incomplete or impacted function of the extremity may be retained to a remarkable degree and perhaps result in failure of detection by the unskilled clinician On certain occasions, sprains may be so severe as to cause total disability for several days 3 *Grating* (crepitus) can be elicited at the fracture, although it should not be sought for as it only adds to the tissue damage already existing 4 Compare the broken with the unbroken part to notice any difference in the shape and length frequently a *deformity* can be seen or palpated 5 *Swelling* of a variable degree will be present in all fractures This swelling consists of edema of the soft tissues which will not become manifest for a few hours However when the swelling is produced by hemorrhage it will be noted immediately after injury 6 *Ecchymosis* is the discoloration of the skin resulting from fracture which has caused hemorrhage into the tissues It is rarely present until several hours have elapsed since injury, at first the discoloration is bluish black but fades to a greenish or yellowish color because of oxidation of the blood pigment 7 Unless the fracture is impacted *abnormal mobility* will be present However no attempt should be made to elicit this sign because of the pain and damage inflicted

General Principles of Treatment Since it is so easy to add further damage to that done by the mishap one should stop look, and listen

Look not alone at the injured person but also at the surroundings The latter may give just as much of a clue as to what should be done as the injured one s actions and position The sounds or absence of sounds (groaning breath sounds) also may give some clues as to the order in which first aid procedures should be administered After having taken proper stock of the situation, decide what might have to be done and determine the order of importance of the signs presented to you in your inventory Secondly, think how you yourself, would like to be taken care of under similar circumstances

One summer recently, at the beach, a group of boys were playing rather roughly and one of them received a fracture of both bones of the forearm It was obvious that there was a fracture as the forearm was bent about 40° One adult immediately rushed up to the crying boy, grabbed the forearm and straightened the angulation, but carelessly dropped it With the aid of a few handkerchiefs he improvised a 'rope' and suspended the forearm from the child s neck, erroneously placing the rope at the site of the break Needless to say, the weight of the hand caused the distal part of the forearm to sag, again allowing a deformity to be produced This uninformed first aid worker added to his errors by then asking the child to go find someone to show him home I doubt that the would be good Samaritan would have chosen to treat himself as he treated this little boy

The objectives of first aid treatment of fractures are

1 *Apply some form of protection or splint* The password is splint them where they lie " The previously mentioned first aid attendant should not have straightened the angulation and let go of the hand Although deformity was present, there was no actual displacement of fragments before he took hold of the forearm However it is probable that the child arrived at the doctor s office with displacement (fragments slipped off past each other) Methods of reduction, etc , are not within the scope of first aid Avoid all unnecessary manipulation since it is painful and may do much local damage
2 *Relieve discomfort and pain* Make the patient comfortable while you are examining him and during transportation, if the injury is of such minor character that it is safe for first aid persons to undertake the responsibility of transporting the injured or in case no physician or ambulance is available Keep the patient warm Comfort and warmth go a long way toward

preventing shock Whether or not stimulants should be administered is controversial Stimulants and sedatives may mask some danger signals

If a doctor s services will be immediately available, nothing need be done except to make the patient comfortable with adequate blankets and place a pillow under his head except in shock, when the head should be lowered If it is clear that a physician will not be available many important *things may be done by the first aid attendant* First make certain that there is no bleeding carefully remove or cut clothing from the injured part Take it for granted that there is a fracture and handle the injured extremity very gently, since rough manipulation is not only painful but tends to produce shock, healing is likewise delayed by the trauma of manipulation The injured extremity should then be splinted as described later After this is completed, the patient is prepared for transportation

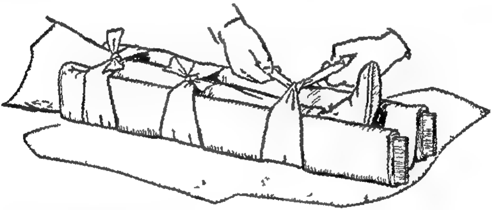

Fig 59 Blanket splint Blanket must be rolled to form a cradle which acts as a sling supporting the extremity

When nature s supporting structure (the bone) is broken, of necessity a substitute support must be supplied to prevent further soft tissue injury and shock Any material or appliance which can be used to accomplish this purpose is known as a splint It need not be a complicated or specialized piece of apparatus A piece of wire or hairpin incorporated in a bandage may sufficiently immobilize a finger An injured limb may be adequately immobilized by bandaging it to the well limb or by binding it into a pillow or blanket (see Fig 59) which is reinforced on two or three sides by wooden splints to afford stability A cane, umbrella baseball bat or similar rigid object may likewise be used Rolled up newspapers make a good splint A plank, ladder or door may be used as a stretcher for transportation of a patient with an injured back or any other serious

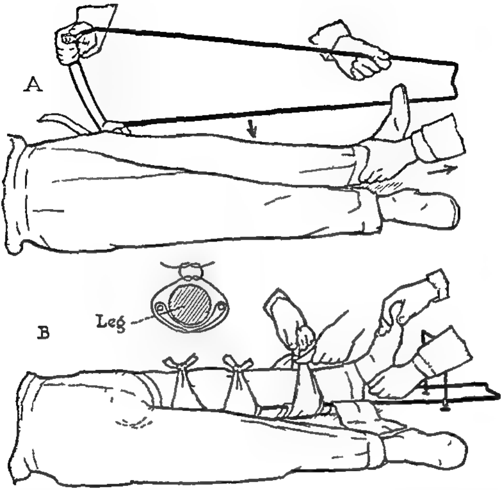

Fig 60 Application of a Thomas half ring (Keller Blake) splint to an injured lower extremity A continuous traction while splint is applied to leg B multiple slings to hold leg in splint with insert showing detail of application

injury The primary object in transportation is to prevent motion at the site of injury which could cause more displacement, which in turn would further injure soft tissues, nerves or blood vessels

An injured arm or leg is best protected in a splint known as a Thomas splint or one of its modifications (see Fig 60 and Fig 71) It consists of a ring large enough to fit over a clothed leg or arm To two diametrically opposed positions of this ring is fastened a heavy U shaped wire which is slightly longer than an extremity There are many modifications of this ring at the present time The most important one, known in the Army as the Keller splint, has a half ring instead of a round ring and the U is fastened through a hinge effect instead of being welded to it rigidly (see Fig 60) To apply one of these splints efficiently requires two persons One person grasps the injured extremity, exerts sufficient traction to keep the muscles and other tissues taut This tension immobilizes or fixes the

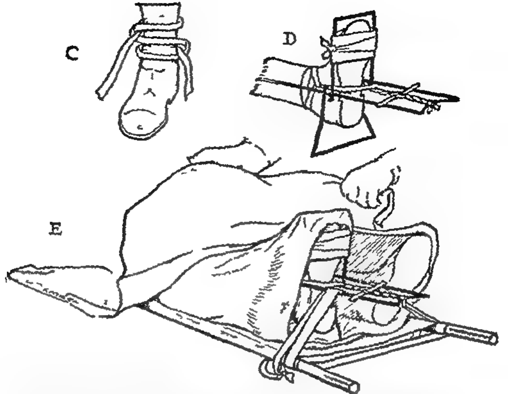

Fig. 60 (cont.) C details of making a Collins hitch. D windlass traction applied for fixed traction with upright support for foot and bottom support to raise heel from cot. E end of Thomas splint anchored to stretcher and patient surrounded with blankets for warmth.

fractured ends by the surrounding tense tissues (flesh, tendons, and skin) and minimizes tissue destruction. Once tension is instituted there should be no relaxation until the limb is fixed in the splint. The second person slips the ring over the foot with the longest bar on the outer side of the leg. The ring of the splint is cautiously snugged into the crotch. A Collins hitch (see Fig. 60C) is fastened about the ankle over the shoe. The ends of the Collins hitch are twisted with a stick to take up the slack (see Fig. 60D). *The extremity now is in what is known as fixed traction, i.e., it is held in a taut position by the splint without outside aid.* The limb itself must be supported in the splint. This might be done by wrapping a bandage about the leg and side bars, or pieces of bandage may be loosely wound from one bar to the other so as to form a hammock or sling in which the limb may lie. Pieces of canvas 4 to 6 inches wide make very satisfactory slings because the material is so stiff that it does not wrinkle. The end of the brace must be supported in such a manner that the heel does not touch any solid support, since certain areas, such as the heel, are prone to develop pressure sores which heal very slowly.

When suspecting a spine injury the injured person should never be permitted to assume a sitting position (see Fig. 61). He should not be

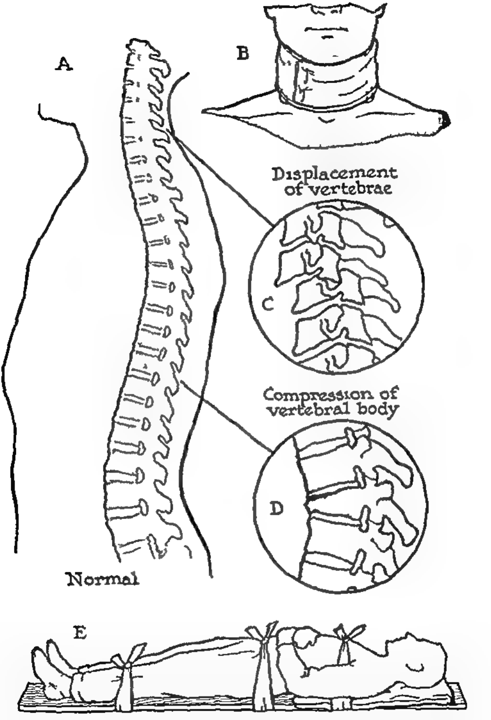

Fig 61 Fracture of the spine A normal spine B reinforced towel collar (Thomas collar) for support of cervical spine C x ray diagram showing forward dislocation of one vertebral body on another D x ray revealing compression fracture of vertebral body E proper emergency immobilization for fracture or dislocation of spine

carried in any way which allows the spine to flex or hyperextend even slightly He should be prone Under no circumstances put pillows under the shoulders in such a way as to flex the spine By the same token it should not be extended It might be an extension injury and you will increase the damage

Specific Fractures FRACTURES OF THE FOOT AND TOES Such injuries occur most *often as a result of a crushing type of force something falls* on the foot or a loaded wheel runs over the foot Fractures of the lower end of the tibia and fibula (the two leg bones) are often mistaken for foot injuries because the foot does not have its normal alignment The foot may point in any abnormal direction, most often outward or inward This fracture consists of an avulsion or break of the bony prominence on each side of the foot, the so-called ankle bones (internal and external malleolus) The fracturing force is usually outward on the foot, or if the foot is fixed as in standing the fracturing force is directed inward The signs of fracture noted will be the deviation of the forefoot and heel away from the normal alignment, and the foot appears to wobble when taking hold of it It is painful Fractures of the little bones of the foot present no changes in shape or alignment so any moderate to severe injury of it should be treated as if there was a fracture

Fractures about the ankle or foot cannot be treated with a Thomas splint as the site of injury is at the level where the anchoring bandage would be fastened Pieces of light metal bent to the contour of the foot and leg, or large pillows or blankets may be bandaged to the foot or leg after the shoe has been removed (see Figs 59 and 62)

FRACTURE OF THE LEG The leg contains two bones A thick one, the tibia or shin bone, is the weight bearing bone If the individual is not too obese, this bone may be felt along the front of the leg from just below the kneecap downward into the inner ankle bone A bone which is not covered by muscles and lies just under the skin is said to be subcutaneous This location is advantageous in fractures as the bone can be palpated (or felt) for evidences of displacement or malalignment The second bone is smaller, is known as the fibula and its purpose is anchorage of the muscles which work the foot It can be felt only at either end. The lower end is the outer ankle bone A fracture of the fibula is usually of slight consequence, and sometimes an injured person walks about for days before he seeks advice because of persistent pain Fractures about the knee are fairly frequent in certain types of automobile accidents, particularly when a pedestrian is hit by the bumper of the car The fracture is of the direct type and usually located just below the knee at the site of impact hence the term *bumper fracture* (see Fig 63), the tibia as well as fibula may be involved

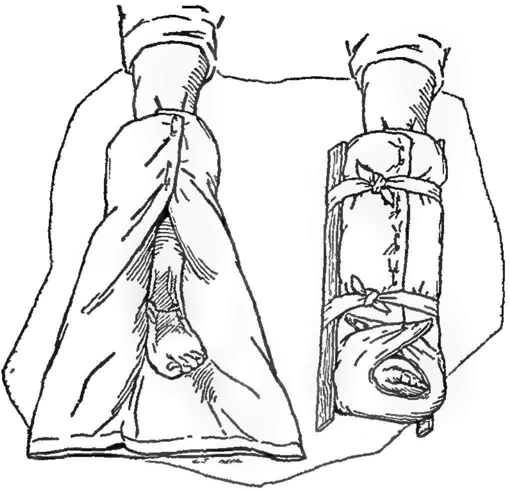

Fig 62 Stability is obtained by pillow splint applied for fractures about the ankle or foot

One of the most common types of fracture about the leg and ankle is a fracture of the fibula an inch or two from the distal end and a break through the lower tip of the tibia Such a fracture is commonly known as a Pott s fracture (see Fig 62) Fractures of the other bone (tibia) are completely disabling Fractures may be at any site Most of them are closer to the lower end than the upper If both bones are broken there will be noticeable deformity and the other signs of fracture If only one is broken a fracture should be suspected on the strength of pain and type of injury and possibly a feeling of unevenness on the cutaneous (skin) surface

Treatment One person grasps the foot applies traction and gently lifts the extremity upward If a Thomas splint is not at hand, a large, long pillow may be applied from the underside, folded over the sides and tied in several places along the thigh, leg and foot Added rigidity may be obtained by placing a few sticks or boards under the bandage over the pillow or a blanket may be rolled from each end and applied after the

manner of the pillow technic (see Figs 59 and 62) If neither material is available, or if there is no one to assist you, a small smooth pad might be placed between the two limbs and the two extremities tied to each other

Fig 63 Bumper fracture affecting the upper end of the fibula as well as tibia Accurate reduction (usually by operation) of fragments which extend into the joint as illustrated must be achieved lest joint disability result

Fractures of the Femur (Thigh) The femur or thigh bone is completely buried in muscle except for the lower broad end which forms the upper part of the knee joint These broad expansions can be felt on the inner and outer side The upper part, known as the trochanter, can be felt about a hand s width below the pelvic ridge in slender peo

ple The site of fracture depends upon the age of the individual All things being equal, children and middle aged adults break this bone in the shaft Older individuals are inclined to break it near the hip socket This fracture is often impacted, that is, the broken ends are driven into each other at the time of the fracture, and the patient is aware only of pain Often they can use the limb as if there were no fracture They continue to use the limb, and at a later date the impaction breaks up and lets them fall Any elderly person who has sustained moderate to severe trauma to the hip resulting in complete disability or pain upon walking should be handled as a fracture victim until proven otherwise If there is

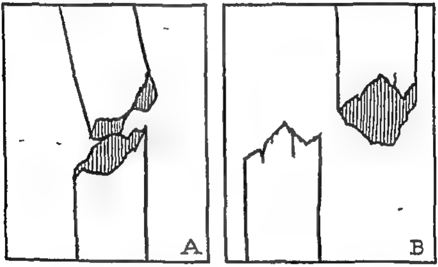

Fig 64 Transverse fracture of femur In A there is no apparent displacement B a view taken at right angles shows displacement illustrating the necessity of more than one x ray view

no impaction the foot will roll outward, and there is likely to be shortening These signs are also present in fractures in other areas of this bone There is overriding in most fractures of the thigh bones Fractures in this bone are more disabling than those in the leg and injuries in this area are more serious so the individual should at once be made comfortable the extremity immobilized and treatment begun to ward off possible shock The limb is to be put into traction, carefully and slowly pulled into alignment with the body and the foot pointed upward A half-ring or Thomas splint is the apparatus of choice If not available a board long enough to reach from the armpit to a short distance below the heel may be used This should be padded, placed under the individual, and tied or bandaged at sites which do not rest on the supporting structure, as the small of the

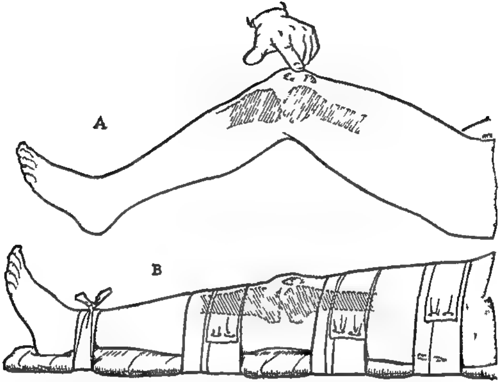

Fig 65 Fracture of the patella (kneecap) A fractured pieces may be felt through the skin Bending the knee pulls fragments farther apart B im mobilization on straight board splint the fracture fragments are almost together

back or hollow of the knee Additional ties are placed over the pelvic region one each over the chest and flank, groin, knee and ankle If no board is available a blanket might be placed between the legs and the limbs bound together as in leg fractures

FRACTURE OF THE PATELLA (KNEECAP) The *kneecap* or *patella* is a small bone lying in front of the knee joint It lies in the substance of the tendon which straightens the knee joint Hence when it is broken the knee cannot be straightened It is fractured by the direct force of a blow or muscle pull Often a depression can be seen and felt at the site of frac ture before swelling takes place (see Fig 65) When fracture is suspected the limb should be immobilized in a straight position i e complete extension This may be done with a pillow or board splint This is one fracture which does not need to be held under traction while the im mobilizing splint is being applied Complete extension is the only requisite

FRACTURE OF THE PELVIS The pelvis is the floor of the trunk Broadly speaking the pelvis is made up of three bones The lower end of

the spine which joins with the two pelvic bones is called the sacrum The two bones which one feels below each flank are known as the pelvic or hip bones Anatomically, each pelvic bone is made up of three smaller bones, the ilium, ischium, and pubis (see Fig 1) The meeting point of the three is near the center of the so called hip bone and is the site of the cup or socket into which the head of the thigh bone (femur) fits Fractures in these bones have become common since the advent of the automobile Fractures in this structure can take on a serious aspect because of the proximity to abdominal organs Organs such as the bladder, bowel, or large blood vessels may be pierced by a sharp bone fragment There is usually severe pain in connection with injuries of the pelvis Shock may be serious Trauma to the abdominal organs is more often associated

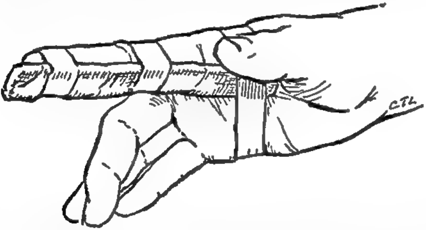

Fig 66 Method of utilizing a padded tongue depressor or similar piece of thin board as a splint for the finger

with severe shock than injuries to an extremity In this instance there are abdominal organs lying next to the fracture When fracture of the pelvic bone is suspected, the injured person should be handled very carefully He should be kept in recumbent position and moved onto some rigid structure such as a padded ladder or board if no stretcher is available

Fractures of the Fingers Such injuries are hard to diagnose The swelling and false point of motion seem the same in a dislocation as in a fracture Each finger contains three phalanges and joints, except the thumb which has two These bones are short Therefore it is not difficult to mistake the deformity of a dislocation for a fracture The indication is to carefully put the finger in the general alignment of a normal finger and splint it with a thin board or metal strip running from the palm to the end of the finger (see Fig 66) or bandage it to an adjacent finger The palm

contains bones known as metacarpals The distal ends of these bones, of which there are five, form one's knuckles These bones are most often broken near the knuckles It is not hard to imagine how it is done—a fight There is swelling and the size of the knuckle is increased in comparison with the ones next to it, or the corresponding one in the other hand The most effective first aid treatment is to bandage the hand with the fingers closed over a ball

FRACTURES OF THE WRIST The wrist is made up of eight small bones placed in two transverse rows The injuring force may be a direct blow or some force which puts the hand through an extreme motion The signs are few As a matter of fact, quite frequently the pain and swelling are slight, and the injured person seeks advice of his physician because of persistence of discomfort in his wrist If a fracture is suspected, bandage the forearm wrist, and hand on a piece of board or folded newspaper

FRACTURES OF THE FOREARM The forearm contains two bones The ulna is on the body side when the palm is pointing forward with the arm at one s side This bone is thick at the elbow and hinges with the arm bone (humerus) to form the elbow joint As it approaches the wrist it becomes thinner It can be felt under the skin (subcutaneously) on the back, or extensor side of the forearm just as you are able to feel the shin bone The bone on the lateral side, or away from the body, is the radius, so called because it is movable This bone moves about an arc with the ulna as the hub The radius is thin near the elbow and abuts on the front of the arm bone beside the ulna It gradually becomes thicker as it approaches the wrist, and becomes quite square at its end to form the base for the wrist joint (see Fig 1) It is buried in muscles except for thin areas between tendons near the wrist

Fractures in the forearm fall into two groups for the purpose of first aid The first group consists of those near the wrist or base of the radius, and should be treated as wrist injuries are treated Those of the shafts of the two bones form the other group and are treated like fractures of other long bones such as the femur tibia and humerus

A fracture of the base of the radius is technically known as a Colles fracture (see Fig 67), the tip of the ulna may or may not be broken This fracture is caused most often by forces that bend or extend the wrist beyond its normal range of motion, as in a fall upon the extended or bent hand A direct blow upon one or the other side may also be the cause A fracture in this region usually develops a deformity shaped like a fork and is known as the silver fork deformity This fracture should be treated like an injury to the wrist bones that is, put the wrist in alignment

with the forearm and place on a board, wire, or newspaper splint This is a more serious fracture than that of the wrist bones and the patient should be put in a reclining position and treated for prevention of shock The forearm and hand should be placed comfortably beside the body, if possible Second choice is to lay it across the chest while preparing the splint After application of the splint, the patient is transported to a hospital for reduction of the fracture by the physician

Fractures in the shafts of the forearm occur at all ages In adults a single bone is more often broken than both, whereas a fracture of both is

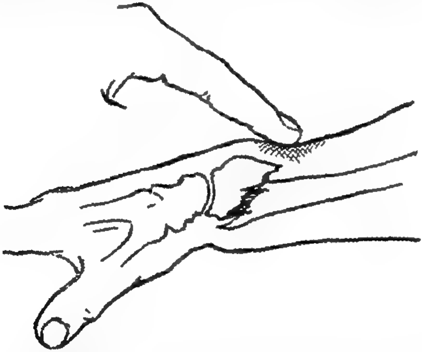

Fig 67 Typical deformity (silver fork) of a Colles fracture Point of tenderness and deformity over a fracture site

more common in children and most of them are nearer the wrist They are sustained by falling on the outstretched hand, or when holding the arm up to ward off blows to the head

The usual signs of a fracture are present A forearm fracture is not as disabling as a fracture in the lower extremity The victim can move a broken forearm and this fact may be misleading Normally when one holds the elbow bent at right angles the palm faces one s body and the thumb points headward This is the position in which the forearm should be held while the splints are being applied The splint may consist of two pieces of board or two rolls of newspaper bound together, one on each

side of the forearm, extending from the elbow to the first joint of the fingers Then the arm may be suspended in a sling

For immobilization after reduction of the fracture, physicians resort to the application of a plaster cast (see Fig 68) or to a board splint which may be utilized by the first aid attendant for the temporary splint (see Fig 69)

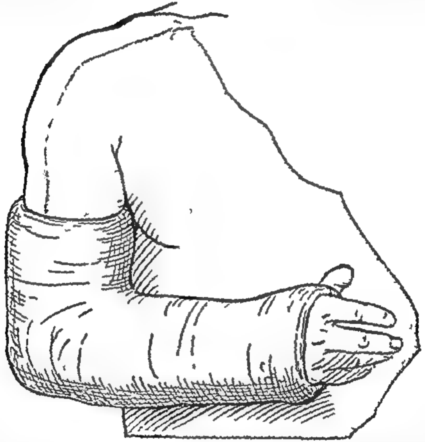

Fig 68 Fracture of the bones of the forearm or wrist Cast extends up over the elbow to prevent twisting of the forearm Fingers and thumb remain freely movable

FRACTURE OF THE ARM (HUMERUS) The arm bone consists of one strong bone the humerus It is entirely covered by muscle except the point where it helps form the elbow joint Here the bone is thin and fan shaped The two edges can be felt They are known as epicondyles

Fractures of the shaft of the humerus present the usual signs of a fracture The arm feels quite wobbly pain is pronounced and disability of the arm is complete The fracture should be protected by means of one

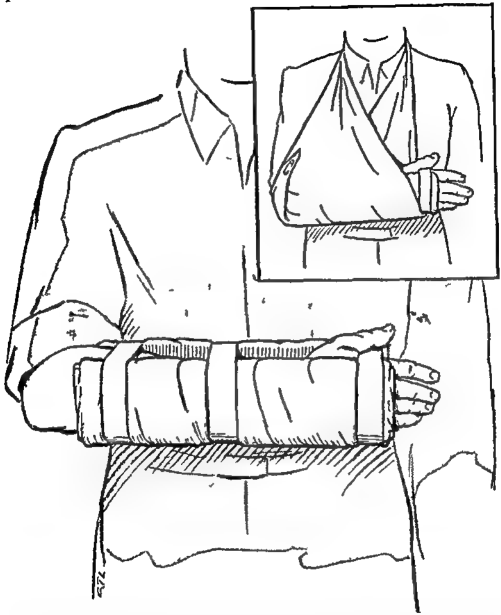

Fig 69 Board splint for forearm injury Triangle sling shown in insert

or two small splints or paper rolls bandaged to the arm or tied with two cravats—one just above the elbow and the other at the level of the armpit During the time the splint is being prepared, the arm may be held by a second person with the elbow at right angles and the forearm across the chest, or the injured person may be instructed to lie down with the forearm placed across the chest just as was done in treating a person with a forearm fracture The forearm may be supported from the neck by means

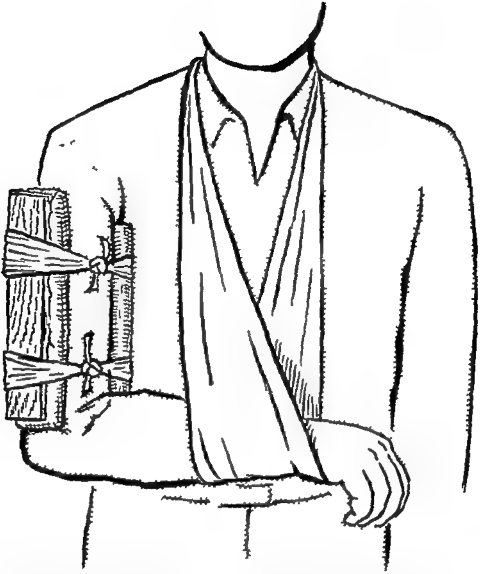

Fig 70 Splinting for fracture of humerus using trunk for immobilization Note that a narrow sling is used the only exception to the use of a triangle sling The bandage about the arm should not include the trunk

of a narrow sling or a simple muslin bandage about the wrist This allows the weight of the forearm to produce traction on the arm (see Fig 70)

Most fractures of the arm in children are through the thin part of bone just above the elbow They are known as elbow fractures Most of them occur with the elbow in complete extension and are known as extension fractures In this type the broken off piece is displaced backward

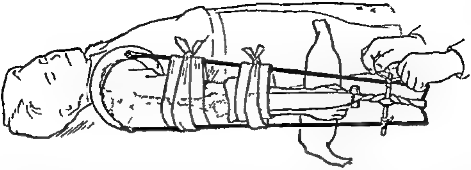

Fig 71 Fracture of humerus using a Murray Jones splint The extremity is suspended by strips of cloth Mild traction is obtained by placing adhesive strips on the dorsal and ventral surfaces of the hand and forearm and attachment of these strips to the end of the splint

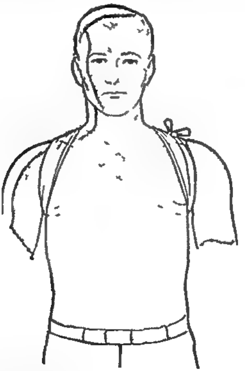

Fig 72 A figure of eight bandage for fracture of the clavicle The forearm on the affected side is placed in a sling

The arm is found in complete extension or nearly so and should be left that way Flexing the elbow may start a train of symptoms which ends in paralysis of the forearm This fracture is moderately shocking The extremity may be splinted by means of a board, stick, or paper roll the length of the arm and forearm

FRACTURE OF THE CLAVICLE (COLLAR BONE) Fracture of the collar bone (clavicle) is a fracture of childhood There is usually disability of the arm because of the pain in the region of the clavicle incident to use The other signs of fracture may be present The shoulders may be immobilized or fixed by means of a figure-of-eight bandage about both shoulders with the cross in the back, or the shoulders may be bandaged to an improvised cross (see Fig 72 and Fig 73) Care must be exercised so that the bandage does not push into the armpit too snugly lest the

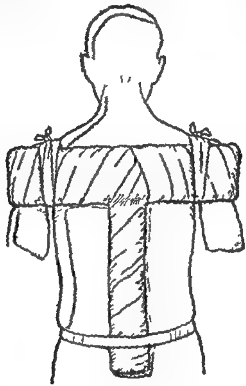

Fig 73 'T' splint for fracture of the clavicle The forearm on the affected side is placed in a sling

blood flow to the arms becomes impaired The arm on the affected side should be put in a sling

Fractures of ribs are fairly common, one of the most common symptoms is pain upon breathing (see also page 246) The coughing up of bright red and frothy blood suggests puncture of the lung by a bone end The author is opposed to any local treatment for this injury Confine yourself to the general care as indicated in any fracture However, many surgeons recommend strapping the chest with adhesive at the site of the fracture

INJURY TO CARTILAGES

Between the bone ends, at certain joints, particularly in the knee and between the bodies of the vertebrae there are elastic, firm structures called cartilages, which serve as protective pads between the bones articulating in the joint. Trauma results in crushing or breaking of these fibrocartilages, such injuries are quite frequent. In certain injuries of the spine, with or without fracture of the vertebrae, the intervertebral cartilaginous discs may be injured. When this fibrocartilage is pushed back into the canal, it then compresses the spinal cord. This condition is called a protruded intervertebral disc. Injury of this type is discussed in detail elsewhere (see Chapter 16).

Injury to Semilunar Cartilage. The bone components of the knee joint consist of the distal end of the femur and the proximal end of the tibia. Between the articulating surfaces of these two bones there is a fibrocartilage which acts as a protective pad located chiefly on the inner border and the outer border of the bones, these protective pads are called the internal and external semilunar cartilages and are held together by supporting ligaments. The internal cartilage existing on the inner border as described above is less freely movable and is very apt to become injured by accidents which are produced by a twisting motion of the knee with the foot firmly fixed on the ground, thus producing a tear or a displacement of this protective pad (semilunar cartilage). Thus one can note that the knee would become fixed or locked in a position of flexion. If this cartilage or protective pad is not completely torn loose from its supporting ligaments, one may by gentle manipulation restore the displaced cartilage or torn cartilage into its normal position. Occasionally one must use an anesthetic to perform this maneuver. Before any attempt is made to replace the torn cartilage it is always a good principle to take an x ray to see whether or not any osseous structures have been injured.

For transportation of these patients to a hospital, it is a good plan to leave the patients in their position of comfort, which is that of flexion supported either by a rolled pillow or blanket, whichever is the handier at the moment.

DISLOCATIONS

A displacement of one bone on another at a joint or place of motion is known as a *dislocation*. The bone ends and the space between them is covered by an inelastic tissue known as a capsule. This capsule is lax ex-

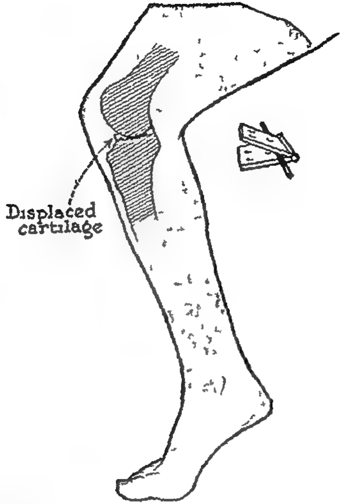

Fig 74 Locked knee caused by a displaced cartilage between bone ends similar to an obstruction in a hinge

cept on two sides of a joint At these areas it is tense and thickened These thickened bands are known as ligaments They give stability to the joint When a force is applied near the joint one bone may become displaced from the other instead of the substance of the bone giving way as is the case in a fracture In order that a dislocation may take place, the ligaments and capsule must be more or less extensively torn Dislocations may occur in any joint

The symptoms are the same as for a fracture, consisting primarily of pain, deformity and swelling The swelling becomes noticeable more suddenly, one reason being that a joint is not so completely covered by muscles There will be no crepitus at the false point of motion as the

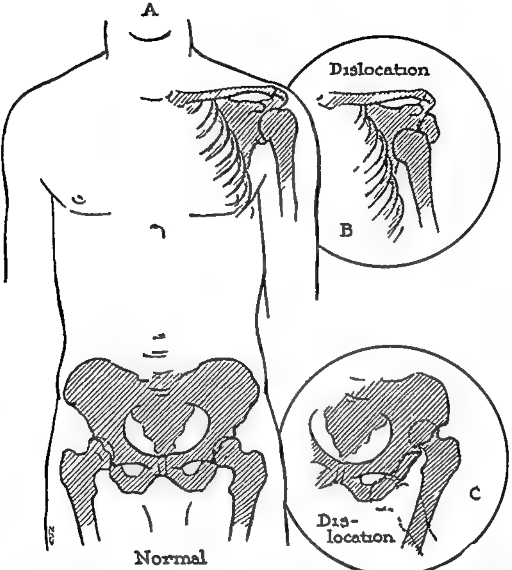

Fig 75 Dislocations of shoulder and hip A normal shoulder and normal hip B the most common type of dislocation of the shoulder is forward and medial C the posterior (upward and backward) dislocation of the hip shown by the shaded area is more common than the anterior (forward and down ward) shown by dotten lines

bone ends in this instance are not rough and sharp but smooth and covered with gristle (cartilage) Nerves and vessels are in close proximity to most joints and for that reason the inexperienced first aid attendant must not attempt reduction Treatment should be confined to general care, splinting, proper immobilization, and transportation to a physician

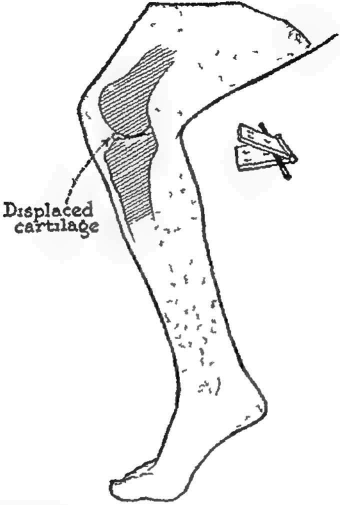

Fig 74 Locked knee caused by a displaced cartilage between bone ends similar to an obstruction in a hinge

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consists of rest for several days, application of heat and a snug bandage to minimize the exudation of fluid into the joint

A charleyhorse is a tear in the substance of a muscle and corresponds to a sprain in a ligament First aid treatment is not very necessary, but should consist of immobilization and application of cold, followed an hour or two later by heat

If the dislocation is present in the upper extremity, the forearm should be carried in a sling, if in the lower extremity, the patient obviously should not be allowed to walk

SPRAINS

Sprains are minor tears in tendons or ligaments The injury is also of tissues about the joint but the injuring force spent itself before tearing became extensive enough to permit a dislocation or a fracture The signs are pain, swelling, and discoloration Heat should not be applied to a fresh injury Heat dilates blood vessels and encourages bleeding which is the cause of the swelling about any injury Apply cold for the first two hours to discourage swelling By that time the injured vessels will be clotted Then heat is used to encourage absorption and healing

A *sprained ankle* is a common injury with which everyone is familiar and will be described as an example of this type of injury It is caused by an accident such as catching the heel of one s shoe on a step, forcing the foot in sudden extension, usually with inversion of the foot (medially) so that the ligaments on the anterolateral surface of the ankle are stretched and torn Pain is variable and dependent upon the severity of the sprain, in severe cases it is so intense that disability is complete Tenderness is present over the anterolateral surface of the ankle, but is much more diffuse than it is in a fracture in which point tenderness is so diagnostic Swelling develops to a variable degree during the first few hours after injury Ecchymosis occurs later, but in mild cases is absent As stated, cold applications should be applied for the first two or three hours after injury, followed later by heat Application of a figure-of-eight type of bandage to the ankle and leg, strongly reinforced with adhesive (see Fig 11) is one of the most frequent methods of treatment It may be two or three weeks before the patient can walk without discomfort In severe cases a light plaster cast worn for several days may allow faster healing It should be remembered that fractures may be sustained along with the sprain Because of this complication an x ray picture should be taken in all severe sprains lest the fracture be overlooked and function resumed too early

Sprains of the knee are common in athletes and may be produced by any type of severe trauma As stated the lesion consists of a tear of the external ligaments *though milder in severity they must be differentiated* from fracture, rupture of the internal (cruciate) ligaments and injury to the cartilage The amount of pain and disability is variable Treatment

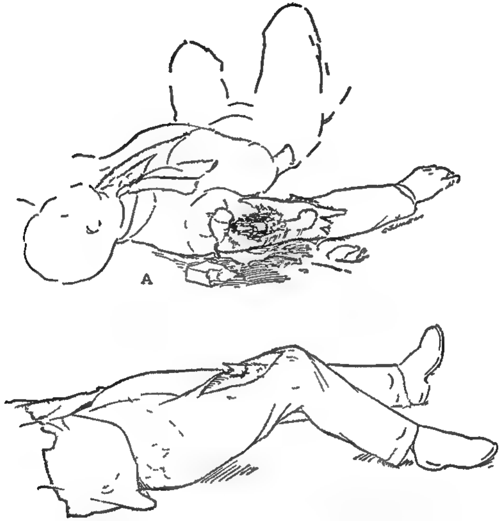

Fig 76 Open fractures A open fracture by direct violence Tissue injury is great and there are apt to be many foreign bodies in the wound B open fracture by indirect violence Contamination is practically limited to the spicule of bone protruding through the skin

agents themselves—bullets shell fragments bomb fragments) are carried directly into contact with the fractured bone ends The infecting organisms are carried in with the foreign material

The second type of open fracture is that caused by indirect violence (see Fig 76B) For example the knee may be severely injured by twisting but the twisting force is directed up the shaft of the femur (the large thigh bone) and a spiral fracture of the femur may occur With the twisting force one end of the spiral fracture may be pushed out through the

12

Open Fractures, Open Dislocations

CLAUDE N LAMBERT

OPEN FRACTURES

Previously, fractures were divided into two groups, the noncompound or simple fractures (greenstick, comminuted, spiral, transverse) and the compound Due to a confusion of terms, and to connote the real type of fracture, the term simple fracture is now referred to as the *closed* fracture and the compound fracture is now called the *open* fracture The new descriptions will be used throughout this chapter By open we mean that the fracture site in the bone or the joint spaces (if the fracture happens to have involved a joint) has been exposed to the outside air To enable this to happen there must of necessity be a break in the skin and muscle, and thus without these safeguards for protection against infection, all open fractures and open dislocations are potentially infected

There may be a cut or laceration near a fracture, and on first examination it may be thought that there has been an open fracture, but careful examination will demonstrate that the skin laceration is really quite superficial and the underlying bone has been protected from contamination by the overlying muscles Hence there is a closed fracture and a laceration rather than an open fracture If there is only a laceration the blood coming from the wound is usually bright red in color, while if there is an open fracture the blood is usually (but not necessarily) darker in color If the wound is carefully inspected, one may see fat droplets in the blood the droplets coming from the marrow cavity of the bone

Types of Open Fractures and Mechanism of Production In general there are two types of open fractures The first one is due to direct violence (see Fig 76A) and is sometimes spoken of as having been compounded from without i e , by the force of the object producing the injury In this instance the external force is so great that not only is there a fracture of the bone, but clothing, dirt, foreign bodies (such as the inflicting

length is well covered by muscles except for the spinous processes of the vertebrae that project behind, and fractures from indirect violence (compression fractures) are almost never open fractures Of couse, with extensive direct violence, even the spine may suffer an open fracture The clavicle (collar bone) is rather exposed but because of its curved structure and relative mobility, fractures of it are seldom open Fractures of the humerus (the arm bone) are not frequently open in the upper end where they have a good muscular covering, but with both direct and indirect violence, they are frequently open at the lower end, near and into the elbow Similarly, fractures of the upper end of the radius and ulna forming the elbow joint are frequently open, while those of the lower end of the radius and ulna are infrequently open Fractures of the small bones in the wrist and fingers are infrequently open unless there is an accompanying laceration or the fracture is the result of industrial accidents such as might be sustained by someone operating a drill which might pierce the fingers or wrist Crushing injuries of the hand or fingers are apt particularly to produce open fractures

Fractures of the ribs are not usually open unless penetration of the lung by the fractured end of the rib would be considered an open fracture, although bacteria are present in the bronchi (air tubes in the lung), they are present in such small numbers in the periphery of the lung that infection of the fractured rib does not develop following puncture of the lung although infection in the pleural cavity might develop

Fractures of the pelvis are not commonly open to the outside through the skin because of a fairly good muscular covering but not infrequently fractures of the pelvis have a spicule that penetrates the rectum bladder, or vagina, and is thus contaminated in that manner (see Fig 77)

Fractures of the hip joint and the upper end of the femur are not commonly open, again because of the excellent muscular covering, but the lower end is more exposed to direct violence, and the percentage of open fractures is increased there The middle third of the femur is frequently fractured by indirect violence, and then becomes an open fracture either by a continuation of the force pushing the fracture to the outside or through improper handling

Fractures of the tibia (shin bone) because of its relatively exposed position are frequently open both by direct and indirect violence Fractures of the ankle with dislocation may cause the tibia to be bared of its skin covering and thus potentially produce an open fracture The foot and ankle are much like the hand and wrist the fractures there become open usually by direct violence

muscles and the skin until the tip of the bone is outside of the skin several *inches away from the site of the fracture itself* Such an open fracture is sometimes spoken of as having been compounded from within, one can readily appreciate that in a case of this kind there would be relatively less chance of contamination, unless the projecting bone was buried in dirt etc , in which case the possibility and probability of infection would again be rather high If, however, the projecting bone end were adequately protected and cleansed before drawing it back in place, the danger of infection would be lessened

The type of force causing the open fracture has a great deal to do with the possibility of infection In civilian life most of our open fractures are at the present time the result of automobile accidents There is usually great force (from the speed of the car), there is considerable damage to the soft parts surrounding the bone thus causing necrotic or dead muscle and skin, and a large area is usually involved This same situation would be true in case of an air raid High explosive bombs have a terrific detonating force and fragments of the bomb itself dirt, brick, or clothing are driven directly into the wound including the site of fracture Thus all of these are very definitely contaminated wounds

On the other hand, a high velocity bullet with a steel jacket may cause very little damage During its course from the gun it travels at such a high rate of speed that the bullet may be sterilized by the friction of the air (heat) If the bullet passes through an extremity it may cause relatively little damage other than the fracture and while in reality it is a contaminated wound there may be no resultant infection This wound may be treated without operation except when it appears grossly contaminated On the other hand should the bullet remain lodged in the tissues it may set up an infection of variable intensity, since foreign bodies *of almost every type encourage the development of infection* However bullet wounds should not be probed and especially is this true in first aid treatment If the bullet is to be removed it should be done under absolutely sterile conditions as may be obtained only in an operating room Should the bullet be a soft-nosed or dum dum type bullet or one fired at close range the wounds are gaping holes especially at the point of exit *and of course, are contaminated*

Common Sites of Open Fractures Certain bones because of their relatively exposed positions are more liable to become contaminated if fractured The skull, for example has a close fitting nonfatty covering and so fractures of the skull from direct violence from the outside are frequently open fractures The spine, in contrast throughout most of its

before the infecting organisms have a chance to grow, we would approach a "clean" wound However, after once being contaminated with the bacteria, these organisms begin to grow and multiply until there is a frank infection present Time is thus a factor in the treatment of these contaminated fractures It is generally considered true that if the open fracture can be treated within six hours from the time of injury, the fracture only is contaminated From six to twelve hours is the borderline stage, and much will depend on the condition of the surrounding muscles blood vessels, nerves, and tissue as to whether or not the wound may be considered as only a contaminated wound and be treated without serious danger of infection After twelve hours the wounds and their accompanying fractures are definitely infected and should be so treated

Most wounds are contaminated by staphylococci and other pus-producing organisms that are present in great numbers in the skin of normal healthy individuals, in all dirt and such Normally the skin is an excellent barrier to infection but once broken the bacteria easily gain entrance even to the deepest part of the wound There may also be streptococci present pneumococci, colon bacilli, and many others Everything that comes in contact with these open fractures has some or all of these organisms on them—the clothing bullets, bomb fragments, shells, pieces of brick In addition, in every one of these open wounds there is the danger of infection by the gas-producing organisms, of which *Clostridium perfringens* is the most common These gas producing organisms are anaerobic, that is, they live and flourish in the absence of oxygen or in the presence of small amounts of oxygen Hence, as pointed out previously, the small punctured wound may be worse than the wide open one because these gas-producing organisms get under the skin, into the soft tissues and into the bone itself In the absence of air they multiply rapidly, give off an extremely potent toxin or poison, and may cause death of the patient in a relatively short time Because of this fact, even small punctured wounds should be carefully cared for with the thought in mind that there is a potential gas bacillus infection

Treatment of Open Fractures The first aid treatment of open fractures must be concerned not only with the care of the fracture site but with possible complications of these injuries

HEMORRHAGE As previously emphasized the first symptom to be treated by a first aid worker is hemorrhage If there is an open fracture, there is all the more need for stressing this point, because the bone marrow is highly vascular, and hemorrhage from it is not easily controlled by pressure because of the bony walls Also, the ragged and

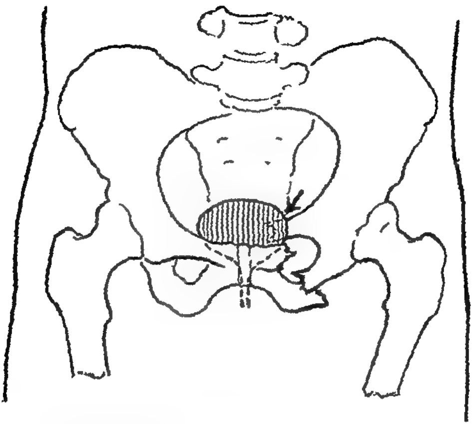

Fig 77 Open fracture of the pelvis A sharp, bony spicule has penetrated the urinary bladder (see arrow)

Infection and Its Importance in Open Fractures The chief factor in an open wound is the possibility or the probability of infection The large wound does not necessarily develop more infection than the small one On the other hand the large wide open wound may at times be less dangerous than the small punctured wound as far as the patient s life is concerned In the large open wound there is sufficient room for drainage, while in the small wound, the opening becomes sealed with blood clots crusts etc and the infection can develop in a closed space Instead of draining to the outside the infection spreads up and down the fascial planes beneath the skin

This brings us to the type of bacterial infection that is usually present All open fractures are contaminated with bacteria, either from the skin or the foreign bodies in the wounds at least some of the bacteria may be assumed to be pathogenic i e capable of causing infection injurious to the patient If the contamination should be stopped right then and there

from direct violence, the bone may be visible deep in the wound, or may not be visible because of the great amount of contaminants, including skin, clothing and dirt In general blood clots and foreign bodies are not removed from the wound before applying the first aid dressing, lest hemorrhage be accentuated No drugs should be placed in the wound Antibiotics should be given to control systemic infection

PREVENTION OF SHOCK The patient s general condition must not be forgotten in the care of the open fracture, the prevention and treatment of shock should not be overlooked Keep the patient quiet, supply warm blankets, fluids, and such, as discussed in Chapter 6

IMMOBILIZATION DURING FIRST AID TREATMENT Immobilization is of utmost importance, and all the precautions mentioned in the previous chapter on the treatment and immobilization of fractures should be thoroughly memorized particularly the part dealing with the movement of fractured extremities Many times closed fractures have been made open fractures because someone was too vigorous in his examination and perhaps forced the sharp bone end through the skin by careless and unnecessary manipulation The common and serious error of encouraging or assisting the patient to walk before an accurate appraisal of his injuries is made may also change a closed to an open fracture

As stated in the paragraph above open fractures should be immobilized in a splint as described in the preceding chapter except that traction is inadvisable when the bone ends are protruding If traction is applied when contaminated bone ends are protruding through the skin, dirt including myriads of bacteria may be dragged into the wound with the bone

ORR TREATMENT This phase of treatment is entirely beyond the scope of the first aid personnel, but is discussed because of its relation to proper first aid treatment and because of its importance in the ultimate result An American orthopedic surgeon, the late Dr H Winnett Orr of Lincoln Nebraska made significant contributions to the care of open fractures In France during World War I, after studying these open fractures carefully, he decided that the immobilization of the fractures, with the open irrigations was decidedly inadequate and that complete immobilization with plaster casts was definitely indicated After careful debridement of the wound and proper reduction of the fracture he packed the wounds open with a nonirritating petrolatum gauze pack and then applied a cast Little or no treatment is required after this until the cast is changed four to six weeks later The theory behind this treatment was that no antiseptic placed in the wound would be strong enough to sterilize

pointed bone ends have added to the hemorrhage by cutting through the surrounding muscles Hemorrhage may be controlled by compression bandages (clean handkerchief in an emergency) or by the use of a tourniquet The use of direct digital pressure (finger in the wound) is not recommended in open fractures or in any other type of wound as previously discussed, because of the danger of adding more contamination deep in the wound from your own fingers

Use of the Tourniquet The value of a properly applied tourniquet and the dangers involved in the improperly applied one must be emphasized again and again Improperly applied, the tourniquet is put on with just sufficient pressure to stop the venous return flow, but not tight enough to stop the arterial flow Instead of stopping the hemorrhage, the bleeding has been increased further by forcing the blood out at the open fracture site *Even though the tourniquet is properly applied a small quantity of* blood may drain out of the veins into the wound

Should it become necessary to apply a tourniquet the time element is important, *if it is left on an extremity for over 30 minutes, it* should be carefully loosened for a few minutes and then properly applied again

In the lower extremity we do not fear the effects of a tourniquet quite as much as we do in the upper extremity With the application of a tourniquet there is compression of nerves as well as blood vessels Permanent *nerve damage may result from an improperly applied tourniquet or from* one properly applied but allowed to remain in place too long

In the application of a tourniquet the first aid attendant should know where to feel for the pulse in the foot (on top of the ankle or behind the medial malleolus on the inner side of the ankle), behind the knee joint, *or at the groin in the upper extremity it is just above the wrist on the* inner side of the arm or at the elbow (see Chapter 7) If the pulse can be *felt in these locations after application of the tourniquet proximally, the* tourniquet is not properly applied Do not apply the tourniquet directly to the skin if it is at all possible to have a little padding under the tourniquet This padding may be an extra handkerchief folded over into one eighth widths or a folded towel Skin and muscles can stand just so much pressure without themselves being injured by the application of the tourniquet

Dressing of the Wound After the hemorrhage has been controlled the wound should be covered with a sterile dressing or as nearly sterile as possible—again using a clean handkerchief freshly laundered sheet or similar material The bone may be clearly seen projecting from the skin if the fracture was caused by indirect violence However if the wound is

wounds should be subjected to debridement, naturally, the chance of development of infection increases as does the time interval elapsing since injury Do not forget to make a thorough, general, detailed examination of your patient We emphasize and repeat this to impress on the first aid worker the importance of not allowing the spectacular open fracture to so absorb his attention that more serious injuries might be overlooked Therefore, do not neglect to make a complete examination

Since the fracture is so thoroughly immobilized by the plaster cast of the Orr method of treatment, one prominent advantage over permanent fixation in splints and pins in military casualties becomes obvious, if it suddenly becomes necessary to evacuate patients to another area, their transportation in plaster casts is far more feasible and safer than in the older method which relies on splints pins and traction for immobilization The authors were convinced long ago of the superiority of the Orr method and have been using it for the past 30 years

Closed Treatment with Traction Although as stated above open fractures in military life are treated almost universally by the Orr method there are still many surgeons who treat them (i e those received within eight hours following injury) in civil life by traction The various phases in this treatment consist of debridement, thorough irrigation reduction of the fracture, closure of the soft tissue by sutures, and fixation in traction There appears to be no doubt that this method is not applicable in the treatment of war wounds Its use in civilian life is definitely controversial, and in many instances may be followed by serious infection On the other hand, if infection develops during the Orr treatment, it is rarely serious

OPEN DISLOCATIONS

Open dislocations in general should be treated in a manner similar to that described for open fractures The open dislocations are usually associated with fractures but not always The danger associated with an open dislocation lies in the possible harm inflicted upon the joint cartilage by infection if this occurs, a stiff joint may result If the infection has been severe enough to destroy the cartilaginous surface of the two opposed bones complete immobility with bony union between the two bones (ankylosis) may result First aid care consists of control of hemorrhage, application of a sterile dressing adequate administration of antibiotics prevention of shock immobilization by a metal or wooden splint and transportation to a hospital where operative treatment, including reduc-

the wound without also causing death of more tissue, furthermore, if the wounds were left open, allowed to drain and heal up from the bottom, there would be no further spread of the infection. Dr Orr started this work in France (although this theory was not original with him, having been suggested by many of the older surgeons and had been tried in a limited way by them) and on his return to this country began following up this work in civilian practice He used the method particularly in the treatment of osteomyelitis (bone infection) and also in fresh open fractures

In the Spanish Civil War Dr J Trueta, chief surgeon of the General Hospital of Catalonia, became a valiant exponent of the Orr treatment, the results obtained by him during that war were so far superior to those reported from previous wars that world-wide attention was attracted to the method. The British were quick to adopt this treatment in their civilian bombings and in their military casualties, calling it the "closed plaster cast treatment." Their results were also excellent.

Early in World War II the United States Army and Navy utilized this treatment but added sulfonamide therapy After controlling hemorrhage, the first aid personnel sprinkled several grams of sulfanilamide in the wound, applied a sterile dressing and whenever possible, a splint. At the hospitals, the more seriously injured soldiers and sailors (with head, abdominal, and chest wounds) were treated first. Because of this priority of wound therapy 24 to 72 hours often elapsed after the bombings before open fractures could be taken to the operating rooms It was later learned that the application of sulfa drugs directly to the wounds was of little value in preventing infection and interfered with wound healing Because of this, the use of drugs in the wound was discontinued. The fractures were reduced, the wounds debrided and packed open, and plaster casts applied. Antibiotics or chemotherapy were administered systemically In spite of the delay in definitive treatment of these wounds, the incidence of infection of the wounds was small and deaths from such infections were minimal, a marked improvement over the results obtained in previous wars.

If a physician will not be available within a short time practically all the nonoperative treatment described in the previous paragraph can and should be carried out by the first aid attendant, assuming that material for this treatment is available Immobilization is best achieved by the full-ring or half-ring splint (see Fig 60A) Morphine should be given to relieve pain and to minimize the possibility of development of shock. It should be emphasized that with very few exceptions, all open fracture

13

Respiratory Emergencies

ARCHER S GORDON

Respiratory emergencies present some of the most urgent problems in first aid and rescue work They require prompt diagnosis and immediate treatment This can usually be provided by well trained medical or nonmedical personnel

Respiratory failure takes immediate precedence over most other emergency conditions Slight delays in the treatment of fractures, shock, head injuries, and various wounds will not seriously alter their ultimate prognosis Even the control of bleeding is usually no more urgent than the restoration of breathing Oxygen is the fuel of living tissues and the fires must be constantly stoked Its absence for periods in excess of four minutes frequently results in irreparable damage or death For this reason, respiratory emergencies fall almost completely within the domain of first aid personnel Proper and adequate action must be taken at once, even a brief delay of no more than two or three minutes may result in death

Normal respiration depends upon simple mechanical principles An understanding of these provides a logical basis for the recognition and treatment of respiratory emergencies

NORMAL RESPIRATION

The normal respiratory cycle is composed of an active inspiratory and a passive expiratory phase These result from the contraction and relaxation of two sets of muscles, the diaphragm and the intercostals

The diaphragm is a firm muscular dome which is attached to the lower borders of the ribs and separates the abdominal contents from the chest During inspiration it contracts and descends to enlarge the thorax This increase in the volume of the chest increases the negative pressure in the closed pleural spaces and results in inflation of the lungs by drawing air in through the nose and mouth During expiration the diaphragm relaxes and rises to its previous position This reduces the size of the chest

tion, will be carried out With early proper care and later well directed properly administered physiotherapy for the joint, most of these patients even though the wound is badly contaminated, will be restored with a good functioning result

With the almost universal availability of multiple antibiotics these should be given to the patient immediately and in sufficient amount The patient, if conscious, should be questioned about penicillin sensitivity and if no history of sensitivity is present, then adequate amounts of penicillin are given At the time of surgery, cultures should be taken the infecting organisms identified and sensitivity tests made Then the best antibiotic can be prescribed Early adequate and continuous antibiotics should be a part of the definitive treatment If the patient gives a history of penicillin sensitivity, and more and more patients are developing this sensitivity, penicillin *should not* be given, but rather another antibiotic

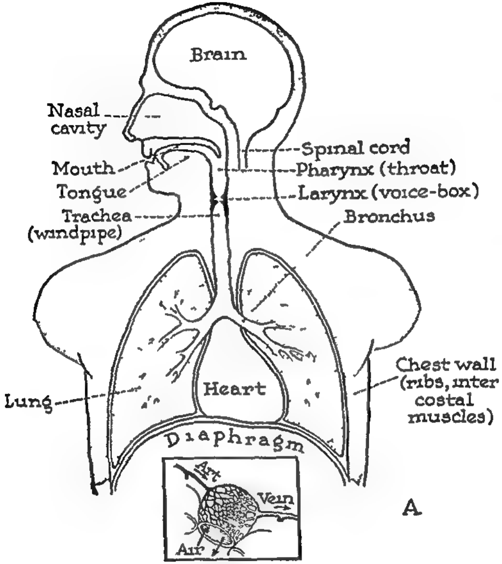

Fig 79 Organs and structures involved in respiration

The air which is drawn into the lungs contains approximately 21 per cent oxygen and a fraction of 1 per cent of carbon dioxide It passes through the nose and mouth, into the pharynx between the vocal cords in the larynx down the trachea and into the bronchial tubes These terminate in microscopic air sacs known as alveoli (see Fig 79)

The walls of the alveoli contain small pulmonary capillaries, which carry poorly oxygenated venous blood from the body tissues In its passage through the lungs this blood is in intimate association with the oxygen

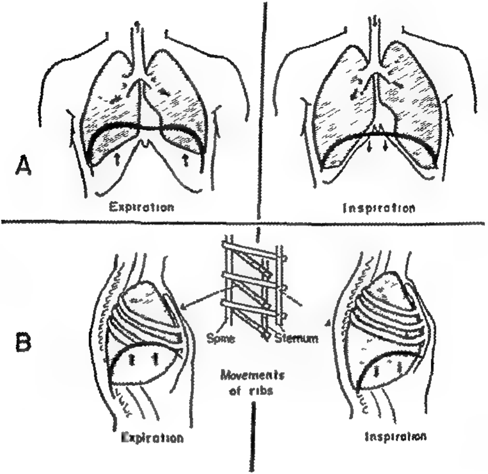

Fig 78 Mechanisms of normal respiration A diaphragmatic—60% of ventilation B intercostal—40% of ventilation

and forces air out of the lungs The pistonlike action of the diaphragm is responsible for about 60 per cent of normal ventilation (Fig 78A)

The action of the intercostal muscles accounts for the remaining 40 per cent of normal ventilation These muscles bridge the spaces between the ribs Their contraction during inspiration lifts the ribs which move on the spine as a *fulcrum to give a bellows or gatelike action* This enlarges the chest in an anteroposterior direction and draws air into the lungs During expiration the intercostals relax and the chest returns to its smaller resting volume (Fig 78B)

The thorax and abdomen expand and contract simultaneously during inspiration and expiration Abdominal expansion is the result of diaphragmatic descent contraction of the intercostals results in thoracic enlargement

RESPIRATORY FAILURE

Failure of respiration is of two main types

1 *Cessation of breathing*
   (a) Partial—respiratory depression
   (b) Complete—respiratory arrest
2 *Obstruction of breathing* (partial or complete)
   (a) Anatomic—obstruction by tongue, pharynx
   (b) Pathologic—spasm, edema
   (c) Foreign body—extrinsic or intrinsic
   (d) Constriction or compression

Injuries of the lung or chest wall may also interfere with normal ventilation Such conditions as tension pneumothorax crushed chest, or severe hemorrhage may threaten life by their interference with ventilation and/or circulation Their occurrence may require urgent treatment of a definitive nature These and related conditions are covered in detail in Chapter 14, Injuries of the Chest

RESPIRATORY ARREST

Respiratory arrest or depression may result from

Causes Acting on the Central Nervous System
- Overdosage of drugs—sedatives, narcotics, anesthetic agents
- Poison gases—nerve gases
- Disease or injury of the brain
- Disease or injury of the spinal cord

Causes Acting on Respiratory System to Produce Anoxia
- Submersion
- Strangulation
- Asphyxiation (smoke smothering, etc)
- Aspiration

Causes Acting on Blood or Circulatory System
- Cardiac arrest or ventricular fibrillation
- Profound shock
- Carbon monoxide poisoning
- Cyanide poisoning

Respiratory depression or arrest are evident when active breathing as manifested by thoracic and abdominal movement, becomes severely

in the alveoli The difference in the partial pressure of oxygen in the alveoli and capillaries causes oxygen to diffuse readily into the blood The huge surface area provided by the millions of alveoli allows this inter change to occur in a fraction of a second

Simultaneous with the uptake of oxygen, carbon dioxide is diffusing into the alveoli from the blood in the pulmonary capillaries Thus the blood returning from the lungs to the heart for distribution to the body has been enriched with oxygen and depleted of carbon dioxide

The air exhaled from the lungs contains approximately 16 per cent oxygen and 4 per cent carbon dioxide Oxygenation and carbon dioxide elimination only occurs in the alveolar sacs not in the bronchial tubes These are merely ducts for the transport of air The air which fills the mouth, trachea, and bronchial tubes at the end of each breath is high in carbon dioxide and low in oxygen since it has just come from the alveoli This is called dead space air and the next breath must be large enough to exceed or flush this dead space volume in order to get adequate fresh air into the alveoli During exhalation the lung is not completely emptied of gas Even after a maximum expiratory effort a ' residual volume ' of about one fourth of the total lung volume remains

In the capillaries of the body tissues an exchange occurs which is the opposite of that just described for the alveoli The partial pressure of the oxygen in the arterial blood is higher than in the tissues, so oxygen diffuses out of the capillaries The converse is true for carbon dioxide and this gas passes from the tissues into the blood The blood then is returned to the lungs to discharge its carbon dioxide and replenish its oxygen

From the foregoing it can be seen that the elimination of carbon dioxide is as important in the process of breathing as is the distribution of oxygen Accumulation of carbon dioxide can be as deleterious as in adequate uptake of oxygen At concentrations of about 20 per cent carbon dioxide begins to act on the body as a depressant or anesthetic agent This brief discussion also emphasizes how important is an ade quately functioning circulatory system in completing the function of respiration

Respiration is normally an automatic function under the control of the central nervous system The regular action of the diaphragm and inter costal muscles is mediated through the phrenic and intercostal nerves to these structures The actual amount of oxygen and carbon dioxide in the blood exerts a strong influence on the automatic control of respiration by the higher nervous centers

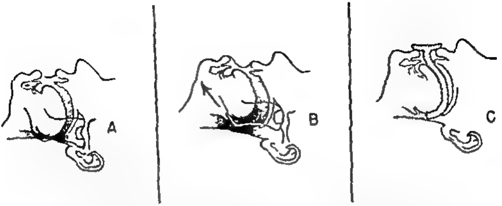

Fig 81 Effect of jaw and tongue position on patency of the airway A jaw relaxed tongue obstructing pharynx B jaw elevated glottic obstruction removed from airway C, oropharyngeal airway used to maintain patency

for haste and the foolish delay associated with loosening of clothing moving or positioning the body, calling for help, looking for adjunctive equipment, etc

The patency of the airway is also of vital importance No matter how well resuscitation is applied, it will be ineffectual unless an open airway assures ventilation of the lungs In the unconscious patient the upper airway relaxes, the head flexes, the jaw drops backward, and the tongue obstructs the airway This position with obstruction of the upper airway is shown in Figures 81A and 82A

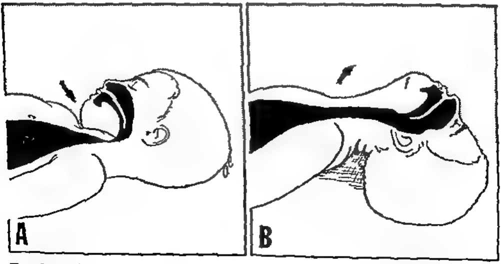

Fig 82 Effect of head and neck position on airway A airway pinched off (obstructed) by flexion of the neck B airway cleared by hyperextension of the neck.

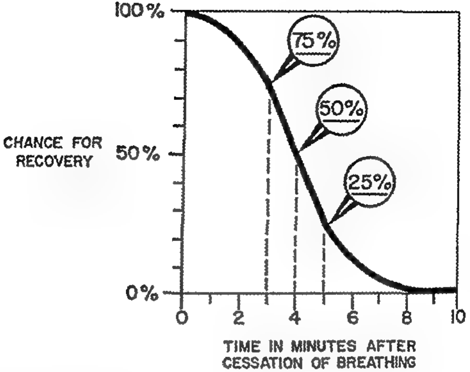

Fig 80 Diagram illustrating the relationship between chances for recovery and time in minutes after cessation of breathing when effective artificial respiration was started

diminished or absent When this occurs resuscitation must be adminis tered

Major Considerations in Resuscitation When breathing ceases there are three major considerations in resuscitation

1 Speed—time is of the essence seconds count
2 Maintain a clear airway
3 Provide adequate ventilation

Any and all resuscitation technics must be evaluated on the basis of these three considerations

Speed is the most important Even a poor method may be lifesaving if applied soon enough Figure 80 shows the relationship between the chances for recovery and the time in minutes after the cessation of breath ing when adequate resuscitation was started Note how your chances for recovery decreases by 50 per cent between the third and fifth minute after cessation of respiration This graph emphasizes poignantly the necessity

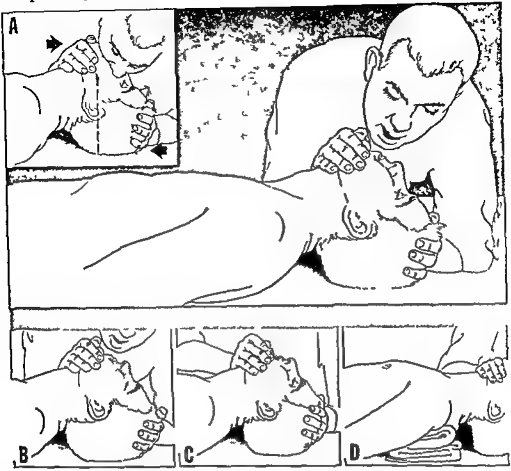

Fig 83 Mouth to mouth and mouth to-nose resuscitation for adults A victim s head hyperextended insufflation phase B mouth to-nose resuscitation area of application C mouth to-mouth resuscitation area of application D pack under shoulders to exaggerate extension of neck

16 per cent oxygen and 4 per cent carbon dioxide, this degree of hyperventilation assures normal oxygenation and carbon dioxide elimination

During mouth to-nose inflation there is no need to seal off the victim s mouth The hand on the chin tends to close the lips and the rescuer s cheek tends to seal off the mouth Mouth-to mouth resuscitation can be performed as shown in Figure 83C Here the rescuer draws apart the victim s lips and makes a wide seal with his mouth over the victim s mouth When available a shirt towel blanket pad etc may be placed under the victim s shoulder (Fig 83D) This allows the head to drop back into a more exaggerated position of extension and aids in maintaining a clear airway With each breath, the rescuer will feel and see the chest rise and

Contrary to the popular notion, placing the victim in the prone position does not remedy this situation as the neck usually remains flexed Since the tongue is attached to the mandible and floor of the mouth, anterior displacement of the mandible (prognathous) makes it obligatory for the tongue to follow and clear the pharynx (see Fig 81B) This can be accomplished by the rescuer placing his fingers behind the angles of the jaw and pushing it forward or by inserting a finger in the mouth grasping the mandible, and pulling it forward However, in actual practice it is much easier to provide a clear airway by placing the victim in the opisthotonoid position by exaggerated extension of the neck as shown in Figure 82B

An oropharyngeal airway may be inserted and will effectively prevent pharyngeal obstruction (see Fig 81C) However, even this simple device is seldom available during respiratory emergencies and its use by unskilled personnel may prove traumatic

When a clear airway has been speedily provided, the rescuer must assure adequate pulmonary ventilation This can be accomplished by mouth-to-mouth resuscitation manual artificial respiration or mechanical devices Mechanical devices are not usually available immediately when respiratory emergencies occur Since time is so crucial it is mandatory that some other emergency technic be started at once

Mouth To Nose or Mouth To Mouth Resuscitation (Expired Air Inflation, Rescue Breathing) This is the most effective method of emergency resuscitation No adjuncts are required and it can be started immediately Since the victim is placed supine and ventilation is accomplished by the rescuer s expired air his hands are free at all times to maintain a clear airway

This rescue technic is best performed as detailed in Figures 83 and 84 The rescuer puts the supine victim s neck into extreme extension by placing one hand beneath the chin and the other on top of the head He pulls up the chin and pushes the head back as shown by the arrows in Figure 83A The victim s chin should point straight upward The rescuer now opens his mouth widely and places it over the victim s nose (Fig 83B) He takes a deep breath and blows into the airway until he feels the resistance of the expanding lungs and sees the chest rise He then removes his mouth and allows the victim to exhale passively

This cycle is repeated 12 times per minute for adult victims Each time the victim exhales the rescuer removes his mouth and takes a fresh breath Each breath he blows in should be about 1,000 ml , or twice his normal resting tidal volume Since expired air contains approximately

may help to eliminate a foreign body or accumulated mucus, blood, vomitus etc

The technic is essentially the same for infants and small children (see Fig 84) Since they are lighter in weight, it is easier to hyperextend their necks and gain a more opisthotonoid position This may be facilitated by first lifting their neck with one hand as shown in Figure 84B The rescuer opens his mouth widely and places it over the child's *mouth and nose* (Fig 84C) He then inflates the lungs about 20 times per minute, varying the amount according to the size of the child This can be determined by watching the chest rise and fall and by feeling the resistance of the expanding lungs Tiny babies may only require small puffs of air from the rescuer's mouth and cheeks

Children's stomachs tend to become distended with air from the inflation If this occurs the rescuer can periodically eliminate this air by moderate pressure on the epigastrium (Fig 84D) However, at no time should he neglect the patency of the airway to accomplish this

If there is a foreign body obstruction in the airway or if the child has been submerged or recently fed and there is much liquid in the stomach, or if regurgitation occurs, he should be picked up and inverted briefly as shown in Figure 84A Frequently a foreign body can be dislodged by several firm slaps on the back in this position

The advantages of mouth-to-mouth or mouth to-nose resuscitation are 1, the speed with which it can be applied to any size victim without accessory equipment 2, the assurance the operator can have on a breath-to breath basis that air is actually entering the victim's lungs, 3, the ability to use both hands continuously to maintain an open airway 4, the greater volume of air exchange which can be demonstrated with this method as compared with the manual methods and 5 the minimal fatigue to the operator even where the victim is large or resuscitation must be continued for a long time

Because of aesthetic considerations a variety of adjunctive devices have been proposed for mouth to-mask or mouth to-airway resuscitation Some of these are useful, some are not In no case does use of such equipment improve the method Valuable time must never be lost in seeking such devices Direct mouth to mouth or mouth-to-nose resuscitation must be started at once When adjunctive equipment becomes available it may be used if desired For emergency use the simpler such devices are the better

Three basic types of adjunctive equipment are shown in Figure 85 These are A a face mask B a double oropharyngeal airway and C, a

fall This is the only emergency technic where the rescuer can assay the effectiveness of artificial respiration on a breath-to breath basis A clean handkerchief or gauze may be used between rescuer and victim for practice sessions or during actual performance However, under emergency conditions this must be considered an adjunct and valuable time must not be spent searching for such items

If airway obstruction is found despite a good position of the jaw, the rescuer should use his finger to search the supralaryngeal portion of the victim's airway Rolling him over onto his side in a head-down position

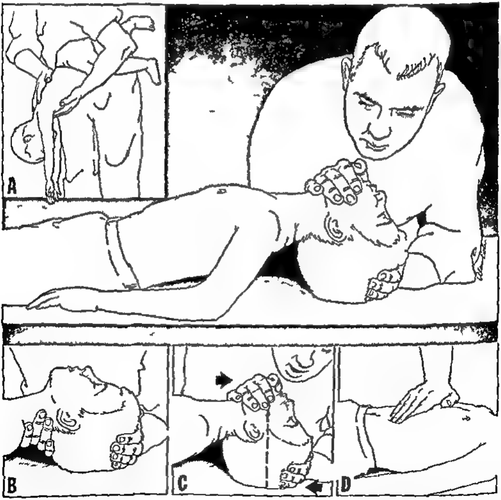

Fig 84 Mouth to mouth resuscitation for infants and children A inversion to eliminate foreign bodies or fluids B lifting to hyperextend the neck C neck hyperextended mouth applied to victim s mouth and nose D pressure over epigastrium to relieve distension by air

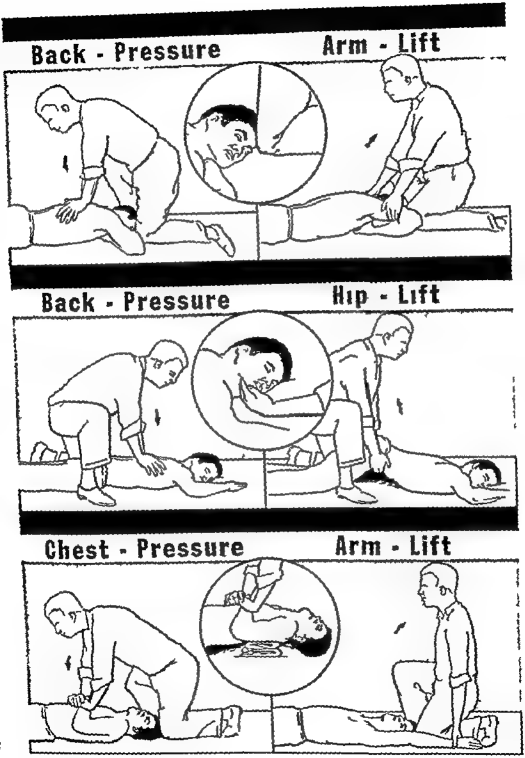

Fig 86 Push pull methods for manual artificial respiration

ADJUNCTIVE EQUIPMENT

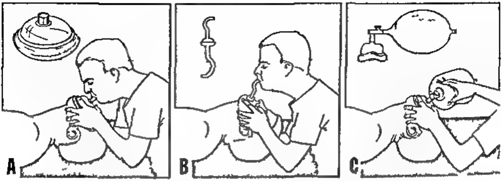

Fig 85 Adjunctive equipment for insufflation of airway A ordinary face mask B double oropharyngeal airway C mask and self inflating rubber bag

mask with self inflating rubber bag The face mask may be a standard anesthesia mask or variation thereof It should be available in sizes for children and adults, and capable of a relatively tight seal to the face The victim's jaw must be kept elevated during its use A flat plastic, collapsible mask which can be carried in the pocket, is also available

The double oropharyngeal airway is more difficult to use, since the fingers must be positioned to seal the lips around the tube and the thumbs to clamp off the nose It may be difficult or impossible for inexperienced personnel to insert, especially if muscle spasm is present Also as the victim regains consciousness the presence of the airway in his throat may provide a stimulus to vomiting

The self-inflating bag and mask are efficient and useful especially during prolonged resuscitation or for respiratory assistance of the recovering or partially apneic victim A non rebreathing valve between bag and mask prevents accumulation of carbon dioxide

Manual Artificial Respiration When direct mouth-to mouth or mouth to nose resuscitation cannot or will not be performed one of the push pull manual technics should be started immediately Three of these methods which produce both active inspiration and active expiration have been tested and found to be effective *if a clear airway can be maintained* These are 1 back pressure arm lift 2, back-pressure hip lift and 3 chest pressure arm lift (see Fig 86)

BACK-PRESSURE ARM-LIFT The victim is placed in the prone position with his hands on top of each other and his head resting upon them The operator kneels at the victim's head and places his hands over the lower portion of the scapulae and the midback with his fingers spread and

pressure almost vertically downward until he feels firm resistance He then rocks backward, drawing the victim's arms upward and back to the ground above his head The chest pressure produces active expiration and the arm lift stretches the pectoral and intercostal muscles to produce active inspiration The patency of the airway can be significantly improved by placing a pillow, blanket towel, or some other form of pack under the victim s shoulders so that the neck will be hyperextended as shown in the inset in the lower part of Figure 86

If manual methods are used, great care must be taken to assure the best possible airway since the operator is so preoccupied with the manipulations that he is not free to maintain patency at all times Furthermore he is not able to determine at any time whether or not he is actually ventilating the subject or how well this is being accomplished With mouth to mouth or mouth-to nose resuscitation these factors can always be determined

MECHANICAL DEVICES A wide variety of respirators resuscitators, and inhalation therapy units have been developed However, most of these are seldom available during respiratory emergencies and their use is restricted to definitive hospital therapy and chronic cases

Portable resuscitators can be used when they become available There is no conflict between direct inflation or manual methods and portable mechanical resuscitators The former must be used immediately the latter can be helpful when available These devices are useful where prolonged resuscitation or oxygen therapy is required, or in the presence of pulmonary edema or bronchospasm They are usually equipped with an aspirator for removing mucus blood or vomitus from the airway It is equally important with such units that a clear airway is assured by keeping the jaw forward or inserting an oropharyngeal airway In addition to resuscitation these devices can be used to amplify depressed respiration and for oxygen administration after normal spontaneous respiration has been re established

Resuscitators provide to the airway either intermittent positive pressure or alternating positive and negative pressure by means of various valving mechanisms They should be equipped with small tanks of medical oxygen and a hook up for adding tanks during use The administration of various concentrations of carbon dioxide (carbogen) is ill advised for resuscitation purposes since the body already contains an excess of carbon dioxide during asphyxial situations The only exception to this is the treatment of carbon monoxide poisoning in which carbon dioxide may tend to displace the monoxide

thumbs touching at the spine He rocks forward and exerts moderate pressure almost vertically downward until he feels firm resistance Then as he rocks backward he grasps the victim s arms just above the elbows and draws them upward and toward himself This is continued until he feels firm resistance He then rocks forward to repeat the cycle, and continues at a rate of about 12 complete cycles per minute

The back pressure forces air out of the lungs and the arm lift produces active inspiration by arching the back slightly, relieving the weight of the body from the chest and widening the intercostal spaces by stretching the pectoral muscles

In order to try to maintain a clear airway, it is best to extend the victim s neck and hook his chin over his wrist The rescuer should place one knee against the forehead to keep it from slipping as illustrated in the top inset of Figure 86

Back-pressure Hip-lift This technic is more difficult to perform when the victim is large or heavy but it provides somewhat greater amounts of ventilation and it is easier to maintain a clear airway The patient is placed in the prone position with the face resting on the back of one hand The operator kneels on one knee at the level of the patient s hips He rocks forward and places his hands over the midback with his fingers spread and the thumbs touching at the spine Moderate pressure is then exerted almost vertically downward until he feels firm resistance He then rocks backward and places his hands under the patient's hips (not waist) Keeping his arms straight, he lifts the hips approximately 6 inches The hips are then replaced on the ground, and the cycle is repeated about 12 times per minute

Back pressure forces air out of the lungs the hip lift allows the abdominal viscera to drop vertically downward Because of their ligamentous attachments to the diaphragm this structure is drawn downward to produce active inspiration Arching of the lower back also aids inspiration

Each time the hips are lifted the body is pulled away from the face This tends to keep the neck extended and aids in maintaining a clear airway When a second rescuer is available he can keep the neck in extension or the jaw pulled forward as illustrated in the middle inset of Figure 86

Chest pressure Arm lift For this method the victim is placed in the supine position with the neck extended and the face turned to one side This extension and turning of the head facilitates the maintenance of a clear airway when the operator s hands are not free The operator kneels at the victim s head and grasps his forearms above the wrists He places the victim s hands on his chest rocks forward and exerts moderate

bronchi and is not seriously impairing ventilation, efforts to dislodge it should not be attempted, as the position may be made worse and subglottic foreign bodies usually require bronchoscopic examination for removal An adult patient may be turned to the side or prone position and the head lowered to attempt removal of fluids such as mucus, blood pus, or vomitus

When laryngospasm or edema of the larynx are the cause of obstruction, only a tube placed into the trachea from the mouth or nose (endotracheal tube) or a tube placed directly into the trachea through the skin (tracheostomy) will be effective Insertion of an endotracheal tube requires special equipment and skill and a certain amount of experience Its use is usually restricted to doctors or specially trained personnel

Tracheostomy can be performed as an emergency procedure Although special instruments and medical personnel are usually required for this procedure it has occasionally been accomplished by relatively untrained individuals using only a pocket knife or razor blade The technic for emergency tracheostomy is outlined in Figure 87 With the neck extended the operator spreads the skin over the trachea to make it tense He then makes a single vertical incision, which is extended down to the trachea after palpating it with his finger Several tracheal rings are then incised and the knife handle or some other blunt instrument is used to spread the edges of the tracheal incision

A simple expediency to establish an airway when the larynx is blocked is to take a large caliber needle or trocar (size 12 to 16) and after feeling and fixing the trachea, pushing the needle into its lumen (see Figure 88A) This will establish enough of a channel to allow some ventilation and/or aspiration of fluids Great care must be exercised so as not to perforate the posterior wall of the trachea and enter the esophagus, and not to slip off the side of the trachea into one of the large blood vessels which lie immediately adjacent to it

Figure 88 also shows the steps in the use of a tracheotome which has been developed for emergency tracheostomies A slotted needle is first inserted into the trachea as described above (Fig 88A) Then a tracheotomy tube having an inner stylette with a blade and ball on the tip is inserted into the slot (Fig 88B) As it is pushed into the trachea the ball rides in the needle slot and the blade incises the skin and the trachea Once inside the trachea the tube is left in place and the stylette with blade and ball is removed (Fig 88C) Although this technic has appeal it is very dangerous in inexperienced hands and must not be used by non-medical personnel

Rescue groups must develop their own set of requirements in selecting a portable resuscitator which meets their specific needs Established medical agencies can provide lists of such approved devices

During the past few years numerous types of various sized small tanks containing oxygen for resuscitation purposes have been made available Since they are small they are readily portable and if used correctly with maintenance of an airway can be very effective although many contain enough oxygen for only 12 to 15 minutes Their advantages and disadvantages have been discussed by Balagot and Sadove (J A M A, 171 36, 1959)

RESPIRATORY OBSTRUCTION

Respiratory obstruction can be partial or complete and may result from many causes If it is severe and prolonged it may lead to respiratory arrest An attempt should be made to treat it before it advances to this stage

Effort to breathe without accomplishing adequate exchange is evidence of airway obstruction Vain efforts at ventilation result in forced breathing accompanied by retraction of intercostal spaces inspiratory stridor or expiratory snoring noises

One of the most common causes of respiratory obstruction is malposition of the tongue and jaw in unconscious or apneic patients If the patient has partial obstruction but is breathing spontaneously, elevation of the jaw or hyperextension of the neck as described above will relieve the obstruction eliminate the noisy breathing and allow him to ventilate adequately If his pharynx is obstructed and he is not breathing after elevating the jaw or hyperextending the neck it is necessary to insufflate the airway by mouth to mouth resuscitation or some mechanical device to determine if further obstruction exists and to maintain adequate ventilation

Foreign bodies are another common cause of respiratory obstruction especially in children It may be caused by aspirated teeth toys food mucus blood vomitus etc When foreign body obstruction is known or suspected the supralaryngeal portion of the airway should be diligently and vigorously explored with the finger to try to effect removal Sometimes a bite block must be used to avoid having one s finger bitten by a semiconscious patient during this maneuver

In the case of a child inverting him and delivering several firm slaps on the back may well dislodge a foreign body If a foreign body lies in the

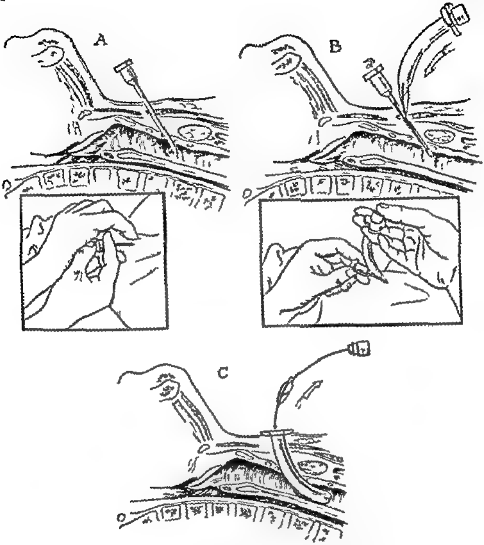

Fig 88 Technic for use of tracheotome

SPECIAL CONSIDERATIONS

These general principles can be applied to most respiratory emergencies They are not all-encompassing but the individual rescuer should be able to adapt them to special rescue situations

In the presence of noxious fumes smoke or carbon monoxide, the victim should always be removed from this environment as soon as possible and before resuscitation is started This may require breaking of windows or doors seeking and eliminating the source of the agent, or using a gas mask to evacuate the victim

Drowning is merely a special form of asphyxia wherein anoxia has

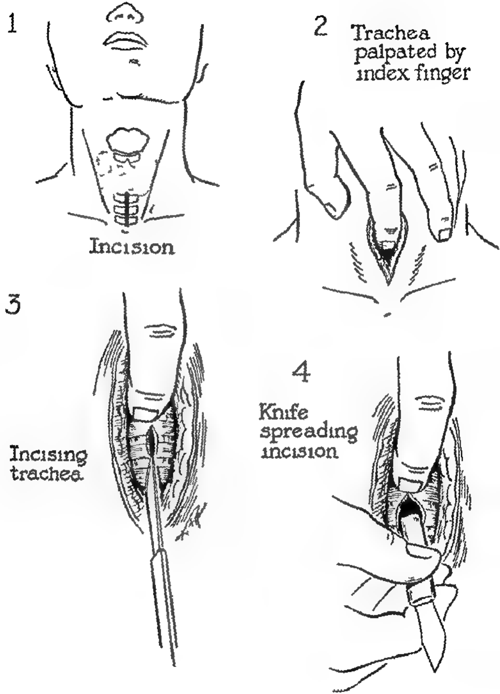

Fig 87 Technic for emergency tracheostomy

this position Lying on the injured side may help splint the moving chest cage and thereby improve respiratory exchange

(b) A snug binder about the chest with added padding over the painful area may be acceptable It should not, of course, be so constricting as to interfere with adequate excursion of the uninjured side

(c) Adhesive strapping is likewise effective but should not be encircling It is preferably placed while the chest is in deep expiration and should not go very far beyond the midline, front or back It is most effective when placed in strips horizontally about the lower rib cage

(d) Clothing should be loosened and cool fresh air should be assured as this is comforting even though it does not contain any increased oxygen Supplemental oxygen is, of course, often necessary and as a temporary means of decreasing the rate of respiration is useful Like narcotics, however, it can render more tolerable the retention of secretions and therefore lead to unwanted side effects

B Derangements of Lung Volume and Function The recognition of the various situations which make up this category of injury is difficult, unless an x ray picture of the chest can be obtained Even though by physical examination alone a diagnosis is generally possible, confirmation by an x ray is advisable except under the direst of circumstances

Alluding again to the previous discussion it is to be recalled that the lungs are not a source of painful sensations Thus except for deep-seated discomfort breathlessness etc, complaints of pain must be ascribed to injuries of the chest wall Fractured ribs, contusions, lacerations and other injuries will produce pain and are to be managed according to the prior discussion The derangements that we are about to discuss generally do not produce pain per se

1 Flail Chest When multiple ribs are fractured at multiple points, the portion of chest wall lying between these areas of fracture will not move in unison with the rest of the rib cage and therefore, it can be said to be flail (see Fig 89) Crushing injuries, such as are seen in today s high speed automobile accidents, account for many if not most of these injuries

The seriousness of this accident depends on the relative size of the segment which is rendered flail Its mechanical importance lies in the fact that on inspiration when the rib cage expands outwardly this func-

paniment of such injuries The principle factors that tend to perpetuate the state of shock are A, pain and B, derangements that reduce the volume of the lungs, thereby reducing their efficacy as ventilatory organs The circulatory system will become affected in consequence of the above

A Pain Whatever its cause (lacerated soft tissues or fractured ribs), pain *is a more serious problem here than elsewhere because it not only* is unpleasant but can affect very seriously vital body functions Thus, since the pain tends to be reproduced with each respiratory movement, especially when ribs are fractured, splinting of the chest occurs on the injured side, restricting its effectiveness in ventilation As bad as this may be, if uncurbed pain can reach such intensity as to cause limitation of motion, even on the opposite side, producing a truly critical situation Oxygenation will then be deficient with cyanosis (blueness) of the patient *and rapid, shallow, grunting respiration Bronchial secretions* will be retained in the tracheobronchial tree, leading to further decrease in efficient oxygenation and ultimately resulting in progressive deterioration of the patient s condition

There are three principal methods of combating this problem These are 1 judicious use of narcotics, 2 intercostal nerve block by procaine, and 3, general supportive measures

1 Narcotics can be harmful by virtue of their side effects, particularly in depressing respiration and cough If used in carefully adjusted dosage to allay pain but not depress, advantage can be taken of this effect to insist on having the subject cough in order to clear the airway and avoid the dangers of sputum retention Narcotics also help greatly in allaying the fear and apprehension often experienced by these person who have had such a vital part of their body affected Obviously, dosage must be carefully regulated to achieve this result

2 Injection of procaine into the intercostal nerves lateral to the spine will interrupt the intercostal innervation relieving pain, and will likewise stop spasm of the intercostal muscles freeing chest wall motion and removing much of the hesitation to breathing and coughing This is the ideal method of controlling severe pain and can be repeated as often as indicated

3 Whereas the two preceding methods require skill and equipment for their performance certain general and simple measures should not be forgotten

(a) The subject s position should be looked into A semirecumbent position is a favored attitude when shortness of breath is a problem, unless there are other injuries to contraindicate

Further, as result of the severe injury, increased bronchial secretions are to be expected Since respiration is hampered and cough is ineffective, retention of these is a consequence and leads to further reduced respiratory efficiency This succession of events accounts for the morbidity and mortality attendant upon such injuries

The flail chest must be stabilized by pressure dressings, balanced traction attached to the ribs or sternum in some fashion, or other methods of overcoming the paradoxical motion The use of mechanical respirators is sometimes required

Control of pain as outlined before is basic and assisted cough is required even before evidence of retained secretions is noted Failing adequate control of the situation by these methods, intratracheal suction by catheter or bronchoscopy is in order, and a tracheotomy (an opening into the windpipe) may ultimately be required as a portal through which secretions may be aspirated It also will tend to relieve paradoxical motion It is necessary for the use of some of the mechanical respirators

2 Pneumothorax This situation can be defined as the presence of air in the pleural cavity (space between the lung and the chest wall) (See Fig 90)

Air enters this space from (a) defects of the chest wall or (b) defects of the lung

(*a*) *Defects of the Chest Wall* When the continuity of the chest wall is disrupted, air will rush in through the defect on inspiration, and the lung which is inherently elastic will collapse apace with the amount of air admitted The lung may become totally airless If the defect in the chest wall is widely patent air will flow in and out synchronously with respiration This is called a *sucking wound* This situation is obviously serious in that the function of one lung is lost by collapse Worse yet however, is the fact that the uninjured side is affected very materially as well because the midline portion between the two lungs (the mediastinum) tends to be pulled toward the good side during inspiration since it is not of itself rigid This partition, therefore being nonrigid tends to follow the lung rather than oppose it as it would were it more resistant to displacement

The size of opening that a person can survive varies, but for short periods of time robust and muscular people can survive openings of remarkable size certainly much larger than the cross section of the trachea (windpipe)

The prime requisite of treatment is of course, to seal this defect by suitable occlusive dressings If these are placed at the end of an expiratory

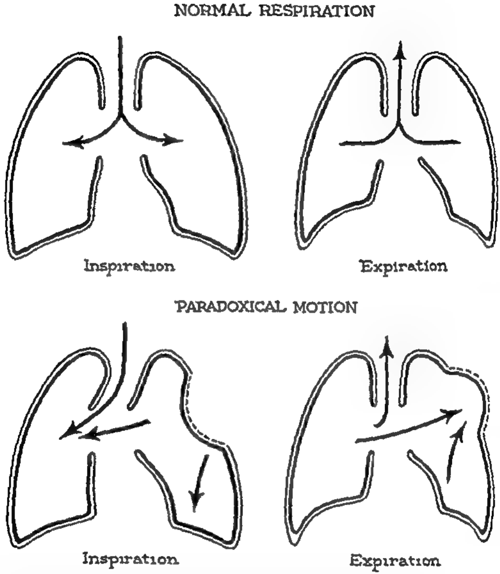

Fig 89 Diagram showing normal respiratory movements and paradoxical motion when the solidity of the thoracic cage is destroyed by trauma

tionally detached portion of the chest wall sinks On expiration the reverse occurs Not only does this paradoxical motion repeat the pain at the fracture site, but air tends to be shuttled back and forth between the area of the lung under the flail segment and the rest of the same lung or, if extensive enough, actually from one lung to the other This latter factor leads to retention of CO_2 and lessened oxygenation as a result of rebreathing These factors obviously deepen any shock that may be present, or may actually produce it

(*b*) *Defects of the Lung* The source of air here is, of course, from the bronchial tree, i e , air which leaks into the chest cavity through a tear in the pleural covering of the lung Small amounts of air in this location may be merely watched, may be aspirated, or if greater in volume, decompressed by catheter as referred to above The amount of air present and the extent of lung collapse under these circumstances will require an x-ray for proper evaluation

At times, however, due to a peculiar ball-valve type of arrangement at the lung defect or pleural tear, more air escapes into the pleural cavity with each expiratory cycle than escapes back from the pleural cavity through the defect This leads to progressive collapse of the lung progressive displacement of the mediastinum, and consequent encroachment on the other side This condition is termed *tension pneumothorax* and can rapidly become fatal The absence of breath sounds over one side (as determined by listening with the stethoscope or unaided ear) or a highly resonant sound when percussion is carried out on this side suggests tension pneumothorax and may justify insertion of a needle for the aspiration of air before the availability of an x ray Such patients are usually severely dyspneic If air under pressure is present, the needle may then be connected to a tube whose end is placed under water, or better yet an intercostal catheter should be inserted and this connected to a water-seal (see Fig 91) In the absence of a water-seal or for the purpose of transportation, a fish-mouthed rubber finger-cot tied over the end of the rubber tubing can be used to permit the egress of air but impede its ingress at the next inspiratory effort Such devices, however, are less reliable than the simple expedient of leading the tube under water in a container placed 2 to 3 feet below the level of the patient s chest

3 HEMOTHORAX This condition is defined as the presence of blood in the pleural cavity The usual source of blood is some injured vessel in the chest wall Wounds of the lung rarely produce bleeding of any great amount because the spongy nature of the organ itself and the relatively low pressure of the pulmonary circulation tend to limit it The spitting of blood (hemoptysis) may be alarming though usually it will be self-limited ultimately ceasing and generally will not be great in total volume The source of blood in hemoptysis is, of course the lung Sedation and rest are the principle approaches to treatment for hemoptysis

In most patients with injury to the chest a variable amount of blood will escape into the chest cavity at the time of an injury Even though it may be small in amount initially, it will evoke an outpouring of pleural fluid within the next 24 to 48 hours An x-ray will show this clearly but

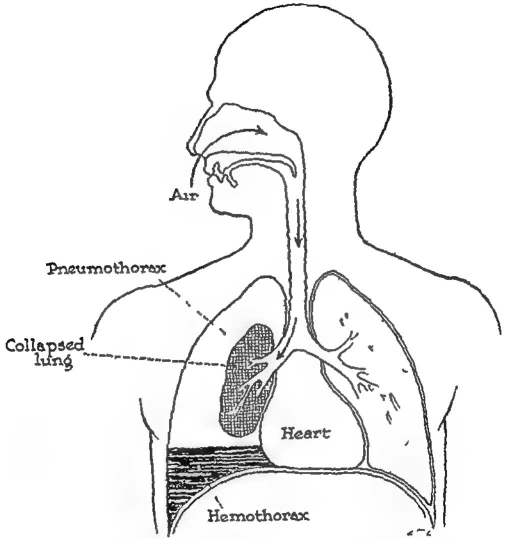

Fig 90 Complications which may arise following wounds of the chest Note the pneumothorax (air in the pleural cavity) collapsed lung and *hemothorax* (blood in the pleural cavity)

effort, maximum use of the underlying lung will presumably be preserved Debridement and surgical closure under an anesthetic is to be carried out at the earliest opportunity

If the defect in the chest wall is transient there being no replacement of the pneumothorax air aspiration of this air by needle or continuous decompression by a catheter passed intercostally into the pleural cavity and connected to a water seal will correct the situation Small amounts of retained air will be absorbed and require no specifically directed treatment

blood does occur This renders aspiration difficult or impossible and calls for special management by the instillation of lysing enzymes, such as Varidase, or surgical decortication at an elective time later

There is little that can be done to control bleeding short of operative exposure, preferably under anesthesia Packing of a chest wall wound may of course, control the bleeding from the muscles or a severed intercostal vessel, but assurance can not generally be had that bleeding into the pleural cavity is effectively stopped by this maneuver Obviously, blood replacement is in order, but no time should be lost in providing for secure control of the bleeding source

4 Subcutaneous Emphysema This condition may be defined as swelling of the soft tissues due to the presence of air This occurs most frequently about the chest wall, neck, and face

Air can find its way into the planes of the chest wall or mediastinum where it distends the tissue This presupposes a break in anatomic continuity of the lung surface or bronchi at some point Once started, this air tends to spread along any of the cleavage planes of the body tissues as it is fed from its source If small in amount its presence may be recognized only by a crackling sensation when the hand is run over the involved area, but if of greater volume it will produce swelling and bloating of all areas affected It may result in a frighteningly grotesque appearance where the eyes are closed, the girth is greatly increased, the scrotum is voluminous, and the neck is massive The legs feet, and scalp may even become involved

The presence of the air itself is innocuous beyond the alarm and discomfort to the victim The important consideration, however, is the source Usually this is from a leak in the lung accompanied by some disruption of tissue planes (pleura usually) permitting the air to migrate Contrary to prior opinions death from emphysema alone probably does not occur and all attention should be directed toward controlling the source as in pneumothorax above In its most massive forms following immediately on injury particularly one without external wound, emphysema results from the disruption of the bronchus itself This situation should be handled by prompt surgical intervention but decompression of the pleural space by one or more catheters may allow time to arrive at the proper diagnosis and surgical correction

Injuries to the Heart These are obviously serious in nature and until recently, much pessimism has overshadowed them It is however, increasingly true that many of these are compatible with recovery by well-directed treatment The possibility that the heart may be contused in

when there are diminished or absent breath sounds over the injured side with dullness to percussion, and when the mediastinum is displaced away from the injured side as determined by the point of maximum impulse of the heart, presumption of fluid in the chest is justified The proper immediate therapy is its removal by needle as necessary for comfort, within a few days all should be removed

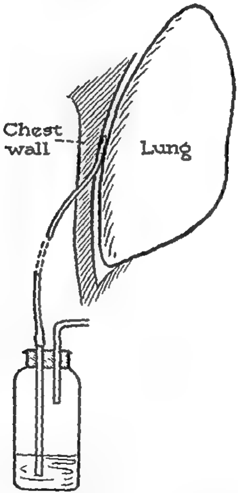

Fig 91 Diagram of the principles utilized in the water seal mechanism often used in the treatment of pneumothorax and after operation on the chest

The diagnosis of continued bleeding into the pleural cavity is often difficult to establish but if suspected calls for prompt and active operative intervention to control the bleeding point The procedure is, however, beyond the scope of this manual

At times, and contrary to former opinion clotting of intrapleural

point of wounding and the presumed course of the wounding instrument generally suggest it as a possibility A state of shock, with low blood pressure particularly in the systolic level, distention of veins (neck and arms), distant or inaudible heart tones, an enlarged cardiac silhouette seen on an upright x ray (if possible) or this same picture at the fluoroscopic screen, where reduced cardiac activity is also recognized, should lead to puncture of the pericardial sac with the recovery of blood on aspiration The presence of inaspirable clots in the pericardium must be considered if free blood is not obtained on puncture when the usual manifestations of tamponade are present This situation strengthens the indication for operative intervention

Needless to say, the transportation to the hospital of such a victim must be accomplished with utmost dispatch The surgical facilities should be mobilized and made available even while the decision for operative intervention is being reached Elevation of the head (semirecumbent position) is usually gratifying to these persons, because venous distention created by the poor cardiac filling (tamponade) is partially relieved by this position

Removal of the wounding instrument (if it remains in site) is accomplished with maximum safety only under direct vision at operation The duller instruments (e g , ice pick) may by their presence minimize the escape of blood from the heart, pulling them out before ready access to the wound is achieved in the operating room may initiate serious active bleeding However serious bleeding can take place around a blunt object in the heart wall accordingly the indications for operation may not be altered by the type of object penetrating the heart

Cardiac Arrest Much has been written glamorizing the heroic aspects of cardiac massage through the open chest when sudden cessation of heart action is believed to have occurred

The emphasis tends to have been centered on the heart as the focal organ in this endeavor It is true that if heart action is not restored, death is certain and in fact can be said to have actually existed It is nonetheless true that the tissue quickest to suffer irreversible damage from lack of oxygen is the brain and that mechanical activation of the heart as a mere pump will bring a flow of blood to the brain as well as to other important areas such as the heart itself Oxygen is the commodity which the blood must transport if success is to be achieved

Without more or less complex diagnostic equipment, certainty that heart action has ceased is difficult to achieve, since some reversible states may well mimic this picture of profound collapse Thus, unless it is cer-

crushing injuries to the chest must always be remembered This type of injury has become relatively common as a result of high-speed automobile accidents

The manifestations of such an occurrence may be ill defined and may be made known only through abnormalities seen in electrocardiographic tracings Symptoms are variable and may even be absent At the present time, rest and protection of the heart from the demands of physical exertion form the basis of medical management, which in many respects is similar to that of myocardial infarction

Much more dramatic, of course, are the lacerations which enter the heart chambers These permit the escape of blood from the heart into the pericardial sac From here the blood escapes into the chest cavity Less often the blood will escape directly from the chamber into the chest cavity or directly to the outside through the wound track

Unimpeded escape of blood leads to death promptly by exsanguination Blood filling the pericardial sac, however, quickly leads to compression of the heart and reduced cardiac function by its choking effect on heart action resulting in cardiac tamponade, which is of itself capable of producing death Those victims whose hearts continue rhythmic beating and are not stopped or thrown into disordered action (fibrillation) by the original physical insult, and who therefore survive to come under observation generally, have established a balance between the amount of blood lost from the circulation on the one hand, and the degree of tamponade on the other

Thus tamponade may be beneficial in preventing death by exsanguination because of its compressive effect on the heart laceration, and yet, the pericardial sac being slow to stretch it may bring about death if the amount of blood forced into the sac is excessive Escape of blood from the pericardial sac into the chest cavity or to the outside will relieve the tamponade but swings the problem now toward one of exsanguination

If the degree of tamponade required to stop the flow of blood from the heart is compatible with life nonoperative management (aspiration) can be considered If aspiration of blood from the pericardial sac can keep an acceptable level of tamponade without bringing on fresh bleeding from the heart wound conservative management may succeed There is obviously a very narrow margin of safety and if tamponade recurs after aspiration, or if there is suggestion that blood is being lost in spite of tamponade open operation evacuating the intrapericardial blood and suturing the lacerated myocardium should be carried out immediately

The recognition of a wound of the heart is generally not difficult The

blood or both in the pleural space, or inability to re expand the lung by virtue of continued air leaks This circumstance often becomes manifest as extensive and extending subcutaneous emphysema The lungs may also be unable to act efficiently as respiratory organs due to the retention of secretions within the bronchial tree

tain that cardiac arrest has occurred and unless adequate means for resuscitation are at hand, a conservative attitude is by far the wiser course

When such catastrophe does take place under circumstances that lend credence to the likelihood of cardiac arrest (e g, during surgical anesthesia or operation), preservation of cerebral blood flow by cardiac massage is indicated Obviously, this should be carried out only by physicians

This is accomplished by a rapid incision over the left chest below the nipple, carrying it into the chest cavity If cessation of heart action has actually occurred, no bleeding should be seen from this incision If, however, active bleeding does occur the incision should not be carried into the pleural cavity since heart action is still present

The heart is then grasped and rhythmically massaged so as to propel blood through it while all other supportive measures are instituted

Since the brain can survive oxygen deprivation for 4 minutes only on an average, no delay can be countenanced if such action is required

SUMMARY

It is obvious that chest injuries and wounds are severe in nature and often very complex in character All aspects herein discussed may occur to varying extents and in varying combinations Analytical approach is however to be cultivated because by so doing, a logical method of treatment will emerge Thus, for example, when confronted by air and blood in the chest resulting from an open defect in the chest wall, closure of the hole and aspiration of the blood and air result in the mechanical restoration to normal Time for ultimate healing is all that is further required

The treatment of chest injuries is basically conservative Operative intervention other than to debride wounds is reserved for 1, wounds involving the mediastinum—the posterior mediastinum in particular, 2, wounds involving the diaphragm 3, tension pneumothorax not controlled by catheter decompression 4, continued intrapleural bleeding not controlled by debridement of the chest wall wound and 5 wounds of the heart

The factors that militate against successful survival following important chest wounds are 1 pain—this is true because of its widespread restriction of ventilatory motion and 2 derangements which reduce the efficiency of the lungs as respiratory organs and thereby adversely affect the circulation as well These factors include collapse of the lung by air,

solid organs, such as the liver, spleen, pancreas, and kidneys, and hollow organs, which include the stomach small and large intestines, gallbladder and bile ducts, and the urinary bladder Injuries to solid organs may result in hemorrhage from them into the general peritoneal cavity as well as a loss of their secretions into surrounding tissues or cavities Hollow viscera, when injured, may emit contents whose danger is dependent upon bacterial flora as well as chemical composition Distended hollow viscera are more easily traumatized and their contents may be more dangerous than the contents of the same organs injured when empty It is difficult to rupture an empty stomach, yet a distended stomach filled with food and gas can be easily torn and its contents poured into the peritoneal cavity This can be serious but does not carry with it the danger of a ruptured colon, which can disseminate its far more lethal contents and produce a more severe peritonitis An empty urinary bladder is seldom injured A distended bladder is frequently ruptured in abdominal injuries, especially those involving the pelvis These points are emphasized to show the importance of determining the time before injury of the ingestion of food or liquids and of the emptying of the patient s bladder

The location and fixation of organs within the abdomen are important in their susceptibility to injury The liver and the spleen although protected by the lower ribs, are vulnerable to injuries which cause fractures of the overlying ribs, while the small intestine, though poorly protected anteriorly and laterally, is seldom injured because of its free mobility within the abdominal cavity The portions of the small intestine which are most frequently injured are those which are more firmly fixed such as the duodenum and upper jejunum and the terminal ileum Thus, it is important in abdominal injuries to consider the anatomy in the area involved and to determine from the history the probable contents of hollow viscera A knowledge of the activities of the patient prior to his accident is most valuable Drinking of alcoholic beverages before an accident is likely to increase the contents of hollow viscera as well as diminish the sensations of the patient

CLASSIFICATION AND TYPES OF ABDOMINAL INJURIES

Abdominal injuries usually are divided into two classes penetrating and nonpenetrating wounds (Fig 92) Penetrating wounds are more obvious and more likely to receive prompt first aid as well as early definitive care However, severe damage may occur to internal organs with no evidence of external abdominal injury This is of great importance to the

15

Abdominal Emergencies

CHARLES B PUESTOW

The tremendous advancements in power and mechanization in both civilian and military life have increased the severity of personal injuries in spite of the developments of precautions to prevent them The potentials of modern warfare jeopardize civilians as well as combat forces Home, industrial, and high speed transportation accidents claim many thousands of lives and injure millions each year Traumatic and industrial injuries now constitute a high percentage of all surgical patients Injuries are frequently multiple and present complex first aid problems as well as therapeutic problems in definitive care Although abdominal injuries are encountered less frequently than those of other portions of the body, they usually are more difficult to diagnose and their symptoms may be masked by other associated trauma Their symptoms are less likely to be apparent and may be delayed in their manifestations

In order to recognize and evaluate symptoms of abdominal injury, one must have a fundamental knowledge of the anatomy and physiology of this portion of the body Injuries to the extremities usually are obvious Fractures of the bones of the arms or legs cause deformity and superficial wounds are apparent Injuries to the head and to the chest, likewise, usually present physical findings and symptoms which aid in the diagnosis

The nature of injuries to the abdomen is influenced not only by the contents of its cavities but also by the nature of its protective coverings The upper portion of the abdomen is protected by the lower rib cage The back of the abdomen is protected by the spine and its associated muscles The lateral and anterior portions of the abdomen have the support of relatively thin and flexible muscle structures The lower or pelvic portion of the abdomen is protected by the lower spine and pelvis Thus the abdomen has relatively little protection on its anterior and lateral surfaces between the lower border of the ribs and the superior border of the pelvis

The nature of the organs of the abdominal cavity greatly influence their vulnerability to injury The abdominal contents may be divided into

person administering first aid He should remember that signs of external violence are not essential to intra abdominal injury This is of increasing importance in our modern age of nuclear energy and other high explosives which can produce blast injuries causing severe intra-abdominal damage with no external evidence of injury

Penetrating Wounds Penetrating wounds of the abdomen are encountered frequently in both military and civilian life Most penetrating wounds through the abdomen sustained during war by troops are due to bullets, shrapnel and flying missiles and fragments of various types If there is a wound of entrance and exit, one may conjecture the probable course of the missile and the organs which lie in its path Most high velocity missiles will travel in a comparatively straight line through the body However, bullets and foreign bodies propelled by explosives may travel devious routes even though they both enter and leave the body and one is never entirely sure of their course One cannot be complacent in believing that because the wounds of entrance and exit apparently do not involve a vital structure no serious damage has resulted Bullets and foreign bodies often will be deflected even by soft tissues and cause damage which cannot be interpreted by a logical, supposed course of their trajectory In civilian life many abdominal injuries of penetrating type are encountered both as a result of gunfire and of sharp weapons These include razors knives, ice picks and other penetrating objects It is well to attempt to determine the direction of the missile from the history given by the patient Often this is erroneous One can only conclude that from the depth the missile is able to penetrate it may have traversed in any direction and he can then interpret what damage may have occurred Lacerated wounds produced by knives and razors usually cause more damage to the abdominal wall than to the contained viscera Stab wounds are likely to produce varying degrees of intra-abdominal injury *It is imperative that patients with penetrating wounds of the abdomen whether they have only a wound of entrance or of entrance and exit be transported to a hospital as soon as possible* where immediate surgical therapy can be instituted if it is deemed advisable Every penetrating wound of the abdomen should be considered a surgical emergency irrespective of how minimal are the symptoms which the patient may present

A compound fracture may present a far more grotesque appearance but may be much less dangerous to the patient than what appears to be a minimal abdominal injury Therefore *abdominal injuries should be given priority in transportation*

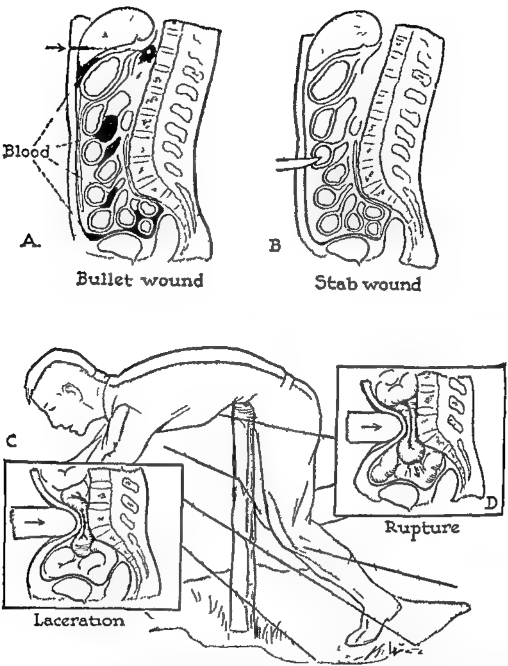

Fig 92 Mechanisms of injuries to organs in the peritoneal cavity A gunshot wound of the liver has given rise to severe hemorrhage B stab wound has injured the intestine C crushing of the intestinal loop between the object and vertebral column (as illustrated by the man falling on the fence post) may produce a laceration of the intestine D injury inflicted as in C may produce a rupture because of sudden pressure exerted on gas in a loop of intestine

hollow and solid, whereas a midabdominal injury is less likely to cause serious intra-abdominal damage. Injury to organs of the lower abdomen usually results from trauma to the surrounding structures, especially the bony pelvis. The symptoms produced by intra abdominal injury often are masked by injury to protective structures. Thus, injury to the liver or spleen may be masked by the symptoms produced by fractures of overlying ribs. *When injury is confined to the abdomen, the symptoms usually* begin in a local area. There may be pain, tenderness, and rigidity of the overlying muscles. If intraperitoneal contamination results, there is usually a progressive spread of these symptoms expanding in the involved quadrant and then extending to the adjacent quadrants until the entire abdomen is involved. This may be followed by a rise in temperature, an increase of leukocyte count, and increasing rigidity and distention. These symptoms and findings are described for the first aid worker only to emphasize the importance of early care of abdominal injuries. Patients with such injuries demand early transportation to the hospital and priority over most other injuries. However, because abdominal injuries are frequently associated with injuries of other parts of the body, one must first and always consider the injured patient as a whole. Shock or impending shock must be treated. Hemorrhage must be controlled. In the presence of trauma to other structures abdominal injuries may be easily overlooked because of the severity of injuries to the chest or the extremities, or because of unconsciousness. External evidence of abdominal injury may be minimal. Blunt trauma to the abdomen, always difficult to evaluate, requires good diagnostic acumen, very careful observation, frequent examination of the patient, and sound judgment. One must carefully analyze the nature of the injury and anticipate what damage may exist within the abdominal cavity.

SYMPTOMS AND SIGNS OF ABDOMINAL INJURIES

Injuries to the abdomen often are difficult to diagnose, even by well-trained physicians. Therefore, they present an unusual challenge to the first aid worker. He must be aware of the fact that abdominal injuries often are slow to develop manifestations and frequently are masked by the symptoms of associated injuries. He must be aware of these difficulties and should have them in mind if the patient is responsive and can be carefully questioned as to the nature of his injury. Much can be learned from a carefully taken history. Diagnostic problems are particularly prevalent in those injuries which do not produce external *evidence* of ab-

Symptoms produced by penetrating wounds of solid viscera, such as the liver spleen, pancreas, and kidneys, may develop slowly They result from the loss of blood into the peritoneal cavity or surrounding tissues or from the loss of secretion from these organs, such as bile digestive fer ments from the pancreas, or urine from the kidneys Bleeding from these organs may be slow but may continue for hours or days Therefore, it is important that the patient be kept under careful observation in order to recognize such hemorrhage and the development of evidences of peri tonitis and shock The loss of secretions from these organs, although accompanied by little bleeding will produce marked tissue reaction and a possible chemical peritonitis and shock

Penetrating wounds of the gastrointestinal tract permitting an escape of contents into the peritoneal cavity will be slow in producing symptoms of peritonitis but the severity of the symptoms and the prognosis will depend upon the portion of the bowel which is perforated Leakage from the stomach and the upper small bowel will produce a chemical peritonitis which results in rigidity of the abdomen, pain, an elevated white count and fever However, because of the low virulence of the bacterial content of these organs, a serious bacterial peritonitis will be delayed Rupture or perforation of the lower small bowel and colon may be slow in producing symptoms but highly virulent organisms may be liberated into the peritoneal cavity, which can produce a rapidly fulminating and possibly fatal peritonitis Because of the uncertainty of the consequences of any type of penetrating abdominal wound, it is most important that a patient with such a wound be transported to a hospital as soon as possible where emergent surgical care can be rendered

Many penetrating wounds of the abdominal cavity are associated with wounds of adjacent portions of the body This is particularly true of wounds of the chest Because the diaphragm arches well into the chest bullets or other missiles may enter the chest penetrate the diaphragm, and injure intra-abdominal structures These are called thoracoabdominal wounds The possibility of such combined injuries must always be kept in mind They are of less consequence to the person administering first aid than to the surgeon giving definitive care Wounds of the buttocks may likewise result in missiles entering the abdominal cavity Such complications could prove very serious if overlooked

Nonpenetrating Wounds The effects of nonpenetrating injuries to the abdomen can be fairly accurately determined by the nature of the force the location of its impact and a knowledge of the anatomy involved An upper abdominal injury can cause serious trauma to fixed organs both

administration of definitive treatment This fact is of great importance in mass casualties where the first aid worker should give priority to patients with abdominal injuries over those with injuries of the extremities, even though the latter may appear to be more severe

Because of the possibility of intra abdominal hemorrhage in abdominal wounds whether penetrating or nonpenetrating, a bandage compressing the abdomen may help suppress hemorrhage This is best accomplished by a *scultetus* or many-tailed binder Such binders consist of a 12 inch square of heavy material, such as flannel, with tails extending out from each side, 3 inches in width and 18 inches in length The square is placed at the back of the patient and the tails are folded across the abdomen, beginning at either the top or the bottom and overlapping each preceding tail, pulling them fairly snug They may be fixed in position by multiple safety pins If such a binder is not available a clean bath towel, pillow case, or portion of a sheet may be wrapped about the patient, pulled tightly, and secured with safety pins Binders should not be extended far upward onto the chest as they will interfere with breathing

If a wound of the abdomen is present, it should be covered with a sterile, or at least clean dressing over which is placed a compression binder In lacerated wounds of the abdomen through which the bowel or other abdominal organs protrude *the first aid worker should not attempt to replace these structures* They should be left on the surface of the abdomen and covered with large sterile or clean cloths (Fig 93) This should be moistened with any sterile nonirritating solution, such as water, saline solution, or plasma If sterile solutions are not available but water can be sterilized by boiling, this should be used to moisten the dressings However, the water should be cooled sufficiently so as not to damage the tissues After covering the exposed organs with wet dressings a compression bandage should be applied over them, snugly but not tight enough to interfere with circulation *The first aid worker should remember not to administer anything by mouth* to the patient with an abdominal injury This is especially true for irritating solutions such as whiskey, which can produce severe inflammation if they leak into the peritoneal cavity

ABDOMINAL PAIN

Abdominal pain frequently is encountered in individuals who have been involved in an accident It may be a steady pain, varying in intensity, which often accompanies some form of inflammatory process If the pain is severe and intermittent (colicky), it generally is produced by obstruc-

dominal trauma Crushing and blast injuries often produce intra abdominal trauma which is masked by lack of external trauma as well as by other associated injuries

Symptoms manifested by the patient are of great value *Nausea and vomiting* especially if the vomitus contains blood should immediately alert the first aid worker to the possibility of intra-abdominal injury *Pain* in the abdomen is another symptom of trauma to its contents Pain, however, may be minimal in the first few hours following injury and often is disregarded because of the predominance of other symptoms It may likewise be masked by unconsciousness, somnolence, shock or mental confusion The signs of abdominal injury may be elicited by careful abdominal examination *Tenderness* is a common finding Its location and intensity may be a guide to the location of the viscera involved and the severity of the damage to it *Muscle spasm* (a stiffening or rigidity of the abdominal muscles) suggests an irritation of the peritoneum (lining of the abdominal cavity beneath the spastic muscles) and aids in localizing the injury Such peritoneal irritation can result from contamination by blood, secretion of abdominal organs, or infection These complications produce peritonitis which is inflammation of the peritoneal cavity and usually requires urgent surgery

Shock often follows peritonitis whether it be on a chemical or bacterial basis The patient will develop not only abdominal symptoms consisting of pain tenderness and rigidity but will show evidences of pallor *a cold and clammy skin a rapid pulse, and low blood pressure* If the patient s condition is too critical to withstand prolonged transportation to the hospital *blood expanders or blood plasma should be administered* intravenously to support the patient until he can receive definitive care (see Chapter 6)

FIRST AID TREATMENT OF ABDOMINAL INJURIES

It is most important for the first aid worker to be cognizant of the dangers of abdominal injuries and to examine the patient for the possibility of their existence Open wounds of the abdomen (penetrating wounds) are easily recognized Intra abdominal wounds due to blunt force (nonpenetrating wounds) may show little external evidence of injury but may be equally serious Wounds of the abdomen along with those of the head and chest should be given priority in transportation to the hospital or to qualified medical care The death rate from abdominal injuries is greatly influenced by the length of time between injury and

tion of some tubelike structure, such as the intestines, bile ducts, or ureters Nausea and vomiting often are associated with abdominal pain Tenderness and rigidity (tightening of the abdominal muscles) may accompany the pain if the lining of the abdominal cavity becomes irritated by a leakage of intestinal contents, bile or urine, or by inflammation The patient may or may not have an elevated temperature Abdominal pain often is serious and needs urgent medical attention

These few "don ts" should be remembered by the layman *Never give a cathartic Do not give food fluids or drugs by mouth* These may not only aggravate serious abdominal disease but if retained in the stomach, increase the danger of the administration of an anesthetic and the possible development of postoperative pneumonia A small low enema is permissible when symptoms are not severe, if constipation is suspected and tenderness does not exist The patient should be kept at rest and if the pain persists, he should be seen by a doctor or sent to a hospital as soon as possible Some of the more common abdominal diseases producing pain will be briefly described

Acute Appendicitis In former years many deaths resulted from acute appendicitis because patients were given strong cathartics such as castor oil or epsom salts This disease usually produces pain which begins in the region of the navel and gradually shifts to the right lower portion of the abdomen Tenderness over the appendix usually can be noted, but the muscles do not become rigid until the disease has irritated the peritoneum Early in the disease the patient s temperature usually is normal Where this disease is suspected, it is most important that no cathartic be given and that all food and fluids be withheld A doctor should be called as soon as possible

Perforated Peptic Ulcer When a peptic ulcer perforates, stomach and duodenal contents are liberated into the peritoneal cavity producing immediate and severe symptoms The pain is steady and intense The entire abdomen rapidly becomes rigid The skin may become cold and clammy, and the patient may present a picture similar to shock although the blood pressure is seldom below normal Any movement of the patient intensifies his pain and he will object to being examined or to having his position changed It is most important that these patients be given nothing by mouth, as anything received in the stomach is likely to cause greater spillage into the peritoneal cavity *Such a patient should be transported to a hospital by ambulance as soon as possible*

Gallbladder Colic This is usually produced by a gallstone blocking a bile duct The pain is in the upper abdomen usually on the right, and

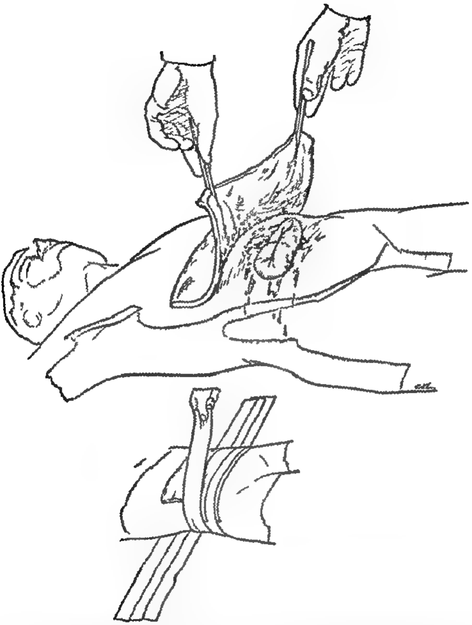

Fig 93 Wound of the anterior abdominal wall resulting in evisceration The loop of intestine is kept warm and moist by sterile moist pads Insert shows method of applying a scultetus binder to afford fixation of dressing It is applied tightly for hemorrhage but loosely when prolapsed intestine is present lest the pressure jeopardize the blood supply to the prolapsed loop

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radiates to the right shoulder blade It is intense, but abdominal tenderness usually is confined to the upper abdomen on the right and rigidity is not marked if present A doctor should see the patient as soon as possible to determine if hospitalization is indicated and to give the patient relief

Renal Colic Stones blocking the ureter (tube leading from the kidney to the bladder) likewise can produce severe pain The pain usually is located in the kidney area and radiates down toward the bladder It may be very intense colicky in nature but has little associated abdominal tenderness or rigidity This is discussed in the chapter dealing with emergencies of the genitourinary tract (Chapter 18)

Strangulated Hernia A hernia is a protrusion of some anatomic structure through a natural or unnatural opening in the wall of its natural cavity Hernias are most commonly seen in the inguinal region (groin) or in the scar of a previous abdominal operation where the deeper layers have partially separated A bulging or mass protrudes due to the contents of the abdominal cavity which are forced into the hernial sac The omentum or a portion of the intestine are most commonly found in hernias If they do not become blocked off and if the blood supply is not impaired, they may not produce symptoms However, if these complications arise the hernia becomes strangulated and pain and tenderness rapidly develop The intestine becomes obstructed and nausea and vomiting frequently occur When such symptoms develop and the mass cannot readily be replaced urgent surgery is frequently necessary and delay may prove fatal Therefore early medical or surgical care is imperative

16

Injuries of the Scalp, Skull, Spine, and Nervous System

ERIC OLDBERG

From the standpoint of first aid, injuries to the scalp, skull, and nervous system form one of the largest groups of accident cases and are among the most important Although statistics vary, it would probably be safe to say that one third of all important injuries during World War II involved these structures, that between one third and one half of the fatalities resulted from such injuries, and that close to 50 per cent of the permanent disabilities resulting from injury were caused by damage in this area Since these structures are of such importance to life and normal function, the principles of first aid for injuries to them are of paramount importance and of great assistance in cutting down the incidence of serious consequences

SCALP

Although the scalp, anatomically, is not a part of the nervous system, injuries to it are considered here because of the possibility of a concomitant intracranial injury The scalp is a very vascular integument and is rather loosely applied to the skull Both of these features are of great importance, are different from the characteristics of tissues or integument elsewhere in the body and are important with regard to treatment Indeed it may be said that because of them, the two chief complications of improper treatment namely, serious hemorrhage and infection are so important

With regard to *hemorrhage* it is common knowledge that the scalp is richly supplied with blood vessels Everyone who has had a laceration of the scalp or who has seen friends or relatives receive such injuries, is aware of the fact that a very small stab wound alone is sufficient to allow the escape of great quantities of blood This is true even if a very small

scalp laceration does not happen to cut an artery If an artery of any size happens to be included in the laceration the resultant bleeding may even be so severe as to be fatal The areas of greatest predilection for such severe hemorrhage are in the temporal region, where the temporal artery has large branches, the occipital region where the same situation exists with regard to the occipital arteries, and the forehead, where the supra orbital artery on each side supplies that region richly with arterial blood Hemorrhage is least likely to be severe near the vertex of the skull at which point vessels which are cut are of the smallest caliber

Since the scalp is normally covered with hair, it is exceedingly difficult to control bleeding from it or to keep the area in a sanitary condition unless the hair is shaved This should, therefore always be done, and the usual rule is that the area to be shaved must leave a margin of at least 2 inches around the laceration The removal of hair is often extremely clumsily done even by persons who should know better Proper removal of hair requires two instruments a hair clipper, either manually or electrically operated both of which are extremely easy to use and one or more old fashioned straight-edged razors kept in good condition Safety razors are anathemas to the experienced head surgeon since they tend to pull hair out by the roots cause pain to the patient and open a large number of hair follicles which may serve as an ingress for infection In shaving the head as a matter of fact, except in dealing with female patients who in selected cases may have a valid reason for preserving hair it is better to clip the entire head and then shave around the lacerated area for a distance of 2 inches as described above Tincture of green soap should be properly lathered into the area to be shaved, beforehand by means of an ordinary piece of gauze preferably sterile When the bleeding laceration has thus been properly exposed it will usually be found to be rough and jagged The chief function of the first aid worker is to stop hemorrhage by exerting pressure on a dressing in the wound if this fails to control the bleeding the artery should also be compressed (see also Chapter 7) *Repair of the wound* as described in the next paragraph is left to the physician

If Novocain is available it is very easy to inject several cubic centimeters of a 1 or 2 per cent solution into the tissues immediately surrounding the laceration This is usually all the anesthetic that is necessary and the laceration can then be spread apart by means of retractors or sterile dressings If a general anesthetic is necessary one of the many intravenous agents may be utilized Pieces of dirt cloth hair and the like should be picked out as carefully as possible and the wound thoroughly irrigated

with warm sterile water or saline solution Ragged pieces of scalp may then be treated, and if the underlying tissues (galea and bone) seem to be intact the wound may be closed if recent, i e, less than 10 hours since injury If there is active bleeding in the edges of the laceration, the novice will find it difficult to stop The scalp is not adaptable to the clamping of individual blood vessels, and therefore hemostats are usually placed on the inner edge of the scalp and flopped over so as to inhibit bleeding by pressure The wound is closed by applying numerous sutures, preferably silk, through the entire thickness of the scalp If there is a considerable amount of soiling and contamination, it is advisable to administer antibiotics A pressure bandage may then be applied, the best material being the elastic weave with which Ace Bandages are made Tetanus antitoxin should be given in all cases in which contamination is significant

The other possible complication from laceration of the scalp, as mentioned above, is *infection* Infection in the scalp may occur for a number of reasons In the first place foreign material may be driven through a laceration into the loose tissues underneath the scalp Second, the presence of hair, which has not been removed in time, and of seborrheic (dandruff-like) material means that there are organisms constantly in contact with the wound Third, the loose application of the scalp to the skull allows pus to burrow rather freely underneath the scalp Fourth it may be impossible to attend a laceration within a reasonable period of time, in which case, the scalp like any other tissue which is not cleaned properly, may become infected The rule to prevent infection if possible, is to debride all lacerations of the scalp as quickly and as thoroughly as possible Here again, shaving of the hair is of paramount importance If the laceration of the scalp is old, i e, inflicted more than 12 hours previously and pus is already present along the edges or between the edges of the wound, then it is better to irrigate the wound carefully remove any foreign bodies present and leave it open so that it can drain, the gaping wound will then heal by granulation from the bottom This is a tedious and time-consuming healing process, however, which carries with it some danger of infection of the underlying bone, and therefore it should be avoided, if at all possible, by prompt and early attention to all lacerations

The above principles are in general, utilized in denuding or scalping injuries the denuded area should be washed off as promptly as possible and cleaned the surrounding hair clipped and shaved, and vaseline gauze laid in place over the raw area The patient should then be sent to the hospital for further and more specialized treatment

SKULL

The skull itself is not inherently important except as a container for the brain By that is meant that ordinary fractures in it do not have the same importance as they do in weight bearing bones, although they may be much more serious because of the damage sustained by the brain Perhaps the most important pathologic manifestations of brain injury are *hemorrhage* and *laceration* of the brain itself These injuries are, of course, the direct result of the blow inflicted on the head and not directly caused by the fracture, except in the occasional instance when loose bone fragments actually produce laceration of brain tissue In addition to hemorrhage and laceration of brain tissue other pathologic conditions may be produced For example fractures of the skull may involve portions of it which allow the escape of cerebrospinal fluid from the spaces around the brain between the edges of the fracture and out through the soft tissues to the outside The two commoner places for this to occur are from the ear and from the nose In wartime it may also happen, to a somewhat lesser degree, from compound fractures of the vault of the skull which tear the scalp fracture the bone and lacerate the dura underneath the bone

In *leakage of watery cerebrospinal fluid* from the nose or ear it will sometimes be surprising to the novice to see the large amount of fluid which may escape in this way—sometimes a quart or more per day This causes loss of body fluids which should, of course, be taken into consideration A more serious aspect of the question, however, involves the fact that a route is open in such injuries for the ingress of infection into the brain or its membranes causing abscess or meningitis If a patient is leaking cerebrospinal fluid from his ear this means that the eardrum has been torn in order to allow the fluid to escape and there will be some blood and probably also some dirt in the ear canal At first impulse it might appear desirable to syringe out this material in order to clean up the field of injury Such a procedure however invites disaster, since syringing may wash organisms back through the laceration into the cranial cavity For this reason in patients with leakage of cerebrospinal fluid from the ear merely swab out the ear canal gently with small pieces of cotton or applicators The patient should then be gently placed on the side from which the leakage comes and the fluid allowed to drain onto towels sterile gauze, cotton or other appropriate absorptive material Such drainage will usually continue copiously for two or three days and will then begin to lessen in amount usually ceasing entirely in about ten days Manipulation and examination of the ear canal should be postponed until several days

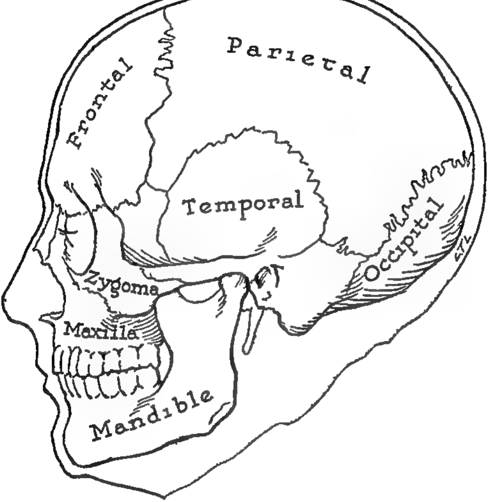


Fig 94 Lateral view of the skull

have elapsed since drainage ceased This, of course, does not mean that the canal should not be kept reasonably clean by means of sterile cotton applicators soaked in oil or glycerine

When drainage of cerebrospinal fluid takes place through the nose, it is well to put the patient in a semireclining position to promote freer drainage The patient should not attempt to blow his nose violently and should simply allow drainage to proceed In these patients having leakage of cerebrospinal fluid from the nose, there is a greater probability that the drainage will persist indefinitely or will recur This sometimes requires subsequent operative repair which is a highly specialized procedure

Drainage of the cerebrospinal fluid out through the wound in a com-

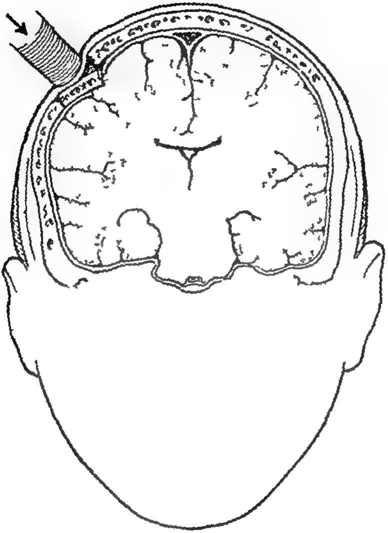


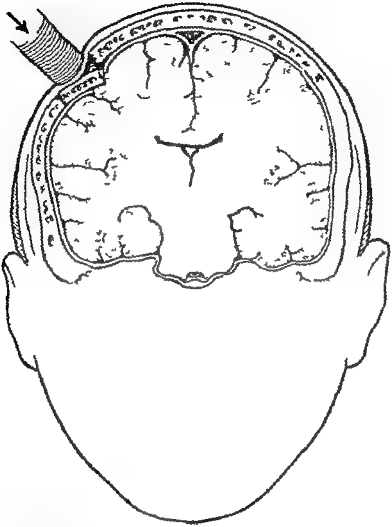
Fig 95 Depressed fracture of the skull which requires subsequent, but not emergency operative correction

pound fracture of the skull is a separate problem which has to do with the care of compound fractures and will be discussed subsequently in this chapter In all patients having cerebrospinal fistula antibiotic therapy should be started as soon as possible as a prophylaxis against infection

Occasionally *fractures of the skull may be depressed* and this may occur with or without laceration of the overlying scalp Such depressions are rarely an emergency problem from the standpoint of surgical correction (see Fig 95) In the vast majority of cases depressed fractures of the skull can be temporarily disregarded and the patient treated along the general principles advocated for the treatment of craniocerebral in

juries, which will be described below under the heading Brain It may be mentioned in passing here that the novice will sometimes be confused as to the presence or absence of a depressed skull fracture In palpating the scalp he may feel a hematoma which has existed for a day or two, the center of which has become liquefied This will sometimes give a cuplike impression and misleads the examiner into the fallacy of thinking that he is dealing with a depressed fracture Since, as stated above, immediate operations for depressed skull fractures are almost never performed, such observation should be of little importance in first aid work, whether or not it is detected However, subsequently most depressed fractures of the skull should be elevated, but this is not a first aid consideration

Compound fractures of the skull are of the greatest importance from the standpoint of first aid, particularly in wartime when their incidence is multiplied many times The term "compound fracture of the skull" implies that there has been a laceration of the scalp, a fracture of the bone, and very often a laceration of the membranes surrounding the brain, and a penetration of the brain itself (see Fig 96) Such fractures are produced by flying particles, by penetrating wounds, like those caused by bullets and other flying objects (shrapnel glass, etc) or by severe falls One usually finds that pieces of bone or metal accompanied by fragments of scalp, hair and dirt have been driven into the brain Of course the immediate concern from the standpoint of first aid involves the possibility of such an injury producing an infection which may take one or both of two forms meningitis or brain abscess The rule in first aid care therefore involves debridement of such injuries as well as is compatible with the existing conditions, but *only by the physician* Gross particles of metal bone hair, dirt, cloth, head covering, and such should be removed as well as possible and the area irrigated with warm, sterile saline solution If a good debridement is possible and the injury is fresh the wound may be closed as described in the first portion of this chapter under Scalp If such is not the case and infection has already set in the head should be shaved, chemotherapy started and the patient taken to the hospital as quickly as possible As has been emphasized in the discussion of wounds elsewhere in this text, cleanliness and debridement of the scalp and skull is of much greater importance than the use of antiseptic substances such as iodine and Mercurochrome Most head surgeons abjure the use of all such substances and rely entirely in their preoperative preparations on careful cleanliness, utilizing bland agents such as soap water, and alcohol If the wound is badly contaminated or infected the patient should be treated with chemotherapeutic agents and antibiotics such as penicillin



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major items of the casualty list A brief description of the anatomy of the brain should be borne in mind by the first aid worker In the first place, it is a very soft, moist organ which is richly supplied with blood It is enclosed in the cranial cavity, and except for the foramen magnum through which the spinal cord enters to its attachment to the base of the brain, it is so tightly enclosed that there is no room in the cavity for the swelling which occurs after injury The cranial cavity is divided into compartments by two very tough and nonyielding membranes One of them runs from front to back in the midline and separates the cerebral hemispheres The other runs from side to side in the occipital region and separates the cerebrum from the cerebellum and medulla Since these membranes are tough and inelastic, one mechanism by which head injuries affect the brain consists of laceration by them when the brain is shifted violently inside the cranial cavity by a gravitational or other force

The brain is enclosed by membranes called the meninges There are three of these The innermost one, which is a thin membrane, is called the pia mater and is applied closely over the entire surface of the brain Just outside of it lies the space in which the cerebrospinal fluid is enclosed This space is about a millimeter or two in depth over the majority of the brain area but over the crevices or sulci of the brain the depth of these lakes of fluid may be considerably greater The fluid space is enclosed by a transparent spiderweblike membrane called the arachnoid The cerebrospinal fluid is therefore referred to as being enclosed in the subarachnoid space Outside the arachnoid, and intervening between it and the bone of the skull is a tough, thick protective membrane called the dura mater The two inner membranes pia mater and arachnoid, are referred to as the leptomeninges and the outer membrane the dura mater, is referred to as the pachymeninx All three layers together form the meninges of the brain Infection usually involves the leptomeninges This complication is serious, since the leptomeninges are in contact with the brain and since the cerebrospinal fluid circulates through them

It should be stated at this point that the brain also contains cavities —one in each hemisphere one in the midline between the hemispheres, and one underneath the cerebellum and lying between it and the pons and medulla These cavities are called the ventricles of the brain and together contain about an ounce of fluid They are connected by means of small openings with the fluid spaces surrounding the surface of the brain and spinal cord They contain the organs which form the cerebrospinal fluid As this fluid forms it passes out through the ventricular system up around the surface of the brain, and down over the surface of the

Finally, other injuries to the skull may be mentioned for the sake of completeness which are rather more technical than the usual problem confronting the first aid worker These involve fractures of the skull through nonsterile areas, such as sinuses, and fractures inducing hemorrhage of such extent that the patient s absorptive process cannot take care of it

BRAIN

Anatomy and Physiology By far the most important structure involved in head injuries is the brain Injuries to it from the standpoint of immediate disability, death, and permanent disability are among the

Fig 96 Compound fracture of the skull Note the pieces of bone and debris driven into the brain

slightly frontwards, he may also be unable to speak, although he may know what he wants to say His ability to express himself verbally is gone because of injury to the speech center

Just behind the Rolandic area there is an ill-defined area called the parietal region This part of the brain is characterized by cells which give the individual the ability to integrate various common sensations into a complete conception Thus, a person putting his hand in his pocket and taking hold of a match box is immediately aware of the article which he has grasped, even though he cannot see it and may not have known it was there This implies that he could feel an object of a certain size, hardness, weight, temperature, roughness, configuration, etc , and integrate all of the multiplicity of those impulses together in his parietal region and thereby instantly acquire the knowledge that his hand enclosed a match box If the parietal area is damaged, however the individual may still be able to tell sharp from dull hot from cold, heavy from light, etc , as separate sensations but he is unable to integrate them and if his hand were in his pocket, he therefore would be unable to distinguish, let us say, a match box from a coin The parietal area of the predominant hemisphere also is the vicinity of centers for comprehension of expression by others that is to say, the ability to understand what is said and to comprehend what is read These functions are therefore impaired in injuries to the parietal region on the left side, in a right-handed person

In the occipital region the centers for vision are located Even though an individual may have no impairment of his eyes or of his optic nerves, the presence of the occipital lobes is necessary for him to comprehend what he sees If both occipital lobes are injured or destroyed the patient is blind as far as conscious vision is concerned If the occipital lobe is destroyed on one side only then the patient loses conscious vision for all objects which fall into his field of vision on the opposite side from the side of this injury Thus if the left occipital lobe is destroyed, the patient cannot see anything to his right, with either eye

The cerebellum is the organ having to do with coordination If an individual has an injury or destruction of the cerebellum his strength is not diminished, but he cannot coordinate his movements Thus, he staggers like a drunken person in walking, cannot handle eating utensils with firm sure movements and is generally clumsy and uncoordinated

The stem of the brain and medulla oblongata contain the centers from which the cranial nerves spring such as those which control rotating the eyeballs moving the muscles of the face protruding the tongue, swal-

spinal cord, the latter structure having the same meninges as the brain This cerebrospinal fluid, which is almost like water in its constituents, is being constantly formed at a high rate (perhaps 2 to 3 quarts per 24 hours) and is constantly being absorbed at the same rate by small clumps of veins which project into the fluid over the surface of the brain, particularly in the region of the vertex Thus, it can be seen that with such an enormous free circulation, infection which gets in at one point is quickly carried by the fluid and spread to all other points over the brain and spinal cord The ordinary forms of meningitis known to the lay person are such infections of the meninges which have been carried by the *circulating fluid*

In order to do intelligent first aid work a minimal amount of knowl*edge regarding the localization of functions in the brain itself should* be at hand As is known to everyone, the brain contains comparatively large regions known as silent areas They are under constant investigation, however, and it will probably be eventually found that there is no portion of the brain which does not have a function The most important areas from the clinical standpoint are described in the following paragraphs

Just in front of the ear and running up to the vertex of the brain there is a crevice or sulcus known as the Rolandic fissure named after an early anatomist named Rolando Immediately in front of this fissure lie the cells which control motor function On the left side of the brain in the left hemisphere these cells control the motion of the right side of the body including the right arm and leg and vice versa The cells nearest the top or vertex of the brain control the leg, and then as one comes down toward the ear over the surface of the brain, the cells in the lower region control the muscles of the trunk, the arm, the face, etc Just behind the Rolandic fissure the corresponding cells for sensation are located, they are distributed in approximately the same manner

In all human beings one side (hemisphere) of the brain is more important than the other this hemisphere is called the predominant hemisphere Since most persons are right handed this means that in most brains the left hemisphere is predominant Since it is predominant the right hand and the right leg are usually more powerful, more delicately coordinated and more accurate In addition in such right handed persons the areas governing expression such as speech or writing, are located in the predominant hemisphere namely the left side Therefore, a right handed person who has received an injury to the left side of the brain, in the region of the Rolandic fissure may be paralyzed on the right side of his body, including the arm and leg, in addition if the injury has extended

slightly frontwards, he may also be unable to speak, although he may know what he wants to say His ability to express himself verbally is gone because of injury to the speech center

Just behind the Rolandic area there is an ill-defined area called the parietal region This part of the brain is characterized by cells which give the individual the ability to integrate various common sensations into a complete conception Thus, a person putting his hand in his pocket and taking hold of a match box is immediately aware of the article which he has grasped, even though he cannot see it and may not have known it was there This implies that he could feel an object of a certain size, hardness, weight, temperature, roughness, configuration, etc, and integrate all of the multiplicity of those impulses together in his parietal region and thereby instantly acquire the knowledge that his hand enclosed a match box If the parietal area is damaged, however, the individual may still be able to tell sharp from dull, hot from cold, heavy from light, etc, as separate sensations, but he is unable to integrate them, and if his hand were in his pocket he therefore would be unable to distinguish let us say, a match box from a coin The parietal area of the predominant hemisphere also is the vicinity of centers for comprehension of expression by others, that is to say, the ability to understand what is said and to comprehend what is read These functions are therefore impaired in injuries to the parietal region on the left side, in a right-handed person

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The stem of the brain and medulla oblongata contain the centers from which the cranial nerves spring such as those which control rotating the eyeballs moving the muscles of the face, protruding the tongue, swal-

lowing, hearing and equilibrium In addition, this vital area contains the centers which are essential to life itself, such as those governing respiration, temperature, pulse rate, and possibly consciousness

With the above brief summary of the gross and functional anatomy of the brain the first aid worker has a conception of the importance of the tissues with which he is dealing The method of dealing with them from the first aid standpoint follows

Injury to the Brain It should be the primary concern of all first aid workers to realize that a patient with a head injury, whether or not there is also an injury to the scalp or skull, or both, has first and foremost an injury to the brain, likewise, it is this injury which is probably going to mean life or death to him, or the possibility of a normal life later if death does not supervene The brain, like any other organ, swells up when injured and there may be bleeding into it Unlike other structures, however this swelling is serious because there is no room for it to take place in the enclosure of the skull The vital centers controlling respiration etc, are therefore placed under embarrassment, since their normal blood supply is squeezed out of normal function and since they may actually be injured by tears or hemorrhages In addition, it should be borne in mind that the essential cells of the brain have no healing power whatever If a bone is fractured new bone is formed to heal the fracture Not one single brain cell however which is destroyed can ever be replaced They are replaced instead by scar tissue which not only has no function but acts as an irritating agent to remaining brain cells and sometimes stimulates them in later life to the point of setting off convulsions

It should be the primary object then of all first aid workers to realize that the *greatest service* that they can do the injured person is to *treat him gently* He should be subjected to the least possible handling X-rays at the time of injury are rarely of value unless there has been a penetrating wound, and this question the operating surgeon himself should decide not the first aid worker The period of a patient s unconsciousness is of importance in evaluating the amount of damage done and this should be carefully observed A particular precaution regarding unconsciousness is that in cases of bleeding following head injuries a patient may be conscious for a time and then lose consciousness Such an occurrence is all the more reason for arranging for hospital care as soon as possible

Other than the above admonishments, the first aid worker should attempt to evaluate the neurologic situation to the best of his ability It is sometimes very important to know whether or not a patient was paralyzed on one side when first seen or whether this paralysis was a subsequent

development Other simple observations can be made which may be of importance, such as inspection of the pupils to see whether or not they are equal in size and which pupil is the larger The larger of two unequal pupils will almost invariably demonstrate the side of greatest brain damage Weakness or paralysis of the extremities on one side of the body is indicative of injury on the opposite side of the brain If the first aid worker carries out these simple principles and observations in conjunction *with the instructions and advice previously given in this chapter regarding* wounds involving the brain, he will be fulfilling his obligations and will be sending back to the hospital an individual in whom proper treatment has been initiated In summation, the watchwords in head injuries are 1, *cleanliness* 2, *gentleness* and 3, *quick hospitalization*

SPINAL CORD

Injuries to the spinal cord may result from direct or indirect trauma Direct injury may be caused in war by bullets or fragments of shrapnel but in civil life most injuries are indirect and result from acute, forcible forward flexion of the spine, since the spongy bodies of the vertebrae are less resistant than the denser laminae

The *thoracic vertebrae are somewhat splinted by the ribs so that the* vertebrae most often involved are in the cervical and lumbar regions When acute pressure is brought to bear by forced flexion of the body of the vertebra, it collapses and is compressed, causing an angulation of the spinal cord This angulation in itself is not enough to cause damage to the spinal cord which lies in the spinal canal, just behind the body of the vertebra and surrounded by the laminae, but fragments may be broken off and project into the canal or the softer cartilaginous disc between the vertebral bodies may be forced backward so as to compress the spinal cord Also the vertebrae may be dislocated from their normal alignment and so impinge upon the spinal cord

If the *spinal cord itself is injured* the results are grave The resulting symptoms tell the neurologist at what level the spine is involved, since the relationship of the spinal segments to the vertebrae is known in great detail Let us suppose first that there is a complete transverse lesion of the spinal cord This may result either from severance of the cord or from local shock which prevents impulses passing the level involved The primary result of such a lesion would be to suppress all motion and all sensation below the level of the lesion By determining the level at which sensation is possible, for example by pricking the skin with a pin the

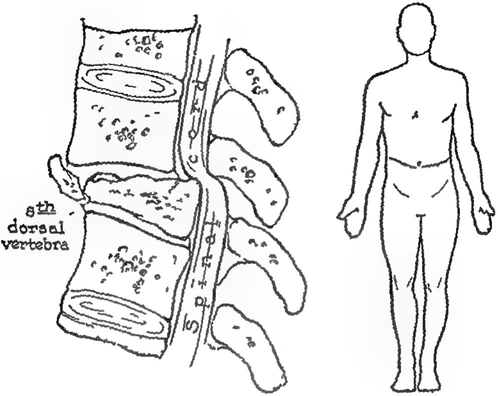

Fig 97 Injury of the spinal cord sustained by fracture of a vertebra

examiner determines the level of the lesion, since the region innervated by each segment of the spinal cord has been accurately determined More over, one can get some idea by simply watching the patient If he does not move any of his extremities and cannot do so on command, the lesion must lie in the upper cervical (neck) region since the upper limbs are innervated from the lower cervical cord If on the other hand the arms are moved freely but the legs are not then the lesion must lie below the lower cervical cord and above the lumbar cord, from which the lower limbs are innervated Any lesion above the sacral cord will cause retention of urine as will also a lesion of the sacral cord itself

In addition to the neurologic signs other means exist to determine the location of the lesion By pressure on the spines one may find that the spine of the involved vertebra is much more sensitive But by all means the most important adjunct to our examination is the roentgen ray X ray photographs are to be made by directing the rays both anteroposteriorly and laterally The lateral plate is very important, since the compression of the vertebral body may not be visible on the anteroposterior photograph

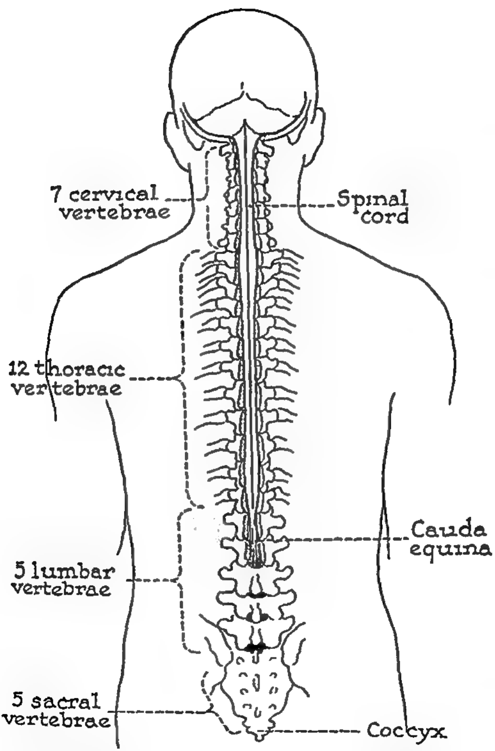

Fig 98 The vertebral column The vertebral column is divided into segments corresponding to the vertebrae however the spinal cord segments are two spaces higher than the corresponding vertebrae

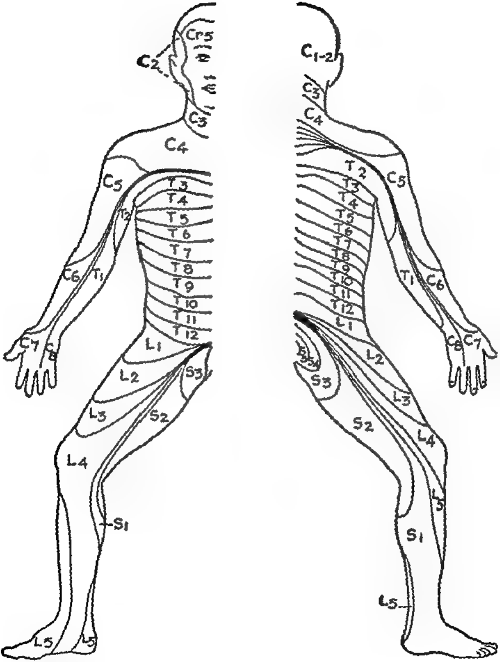

Fig 99 Peripheral distribution of the various spinal nerves

The *treatment of spinal cord injuries* is very important because such injuries are so serious The fact that the vertebral body is usually collapsed and the angulation of the spinal canal is forward is very important in the handling of a patient with an injury to the spine, since an attempt to move or carry the patient in the usual way, or on the usual stretcher, will tend to increase the anterior curvature of the spine and may cause further damage to the spinal cord

When called to see a patient who is suspected of having an injury to the spine a very careful inspection should be made before attempting to *move him If the patient cannot move either arms or legs or cannot move* the legs and only imperfectly the arms, the injury is to the cervical region and the problem of moving him becomes very grave The important feature in the treatment of fractures of the spine with suspected or proved injury to the spinal cord is to insure safe transportation to a hospital and *avoidance* of further injury which might be inflicted during transportation Carelessness in transporting patients with a fracture of the cervical vertebrae is particularly liable to result in damage to the spinal cord Three or more strong people are necessary to move a patient with a cervical fracture The head *must not be rotated* but *must be held rigidly in perfect* alignment with the thoracic spine and extended The body must be lifted by two strong men, while another pulls the head and holds it straight and

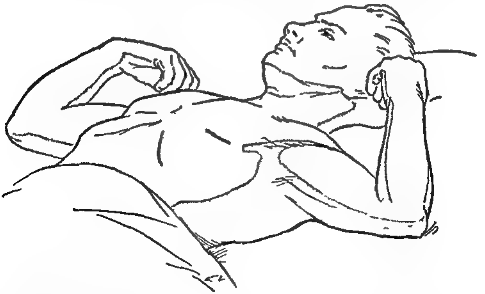

Fig 100 Position and attitude of the arms in a fracture located in the region of the sixth cervical vertebra with injury to the spinal cord

a fourth pulls in the opposite direction at the feet The patient is then laid flat on his back on a rigid floor or plank (if necessary take a door off its hinges and use it as a stretcher) with a sandbag or other solid object on either side of the head to keep the neck in alignment When the patient reaches the hospital the same care must be exercised, especially in taking x ray photographs

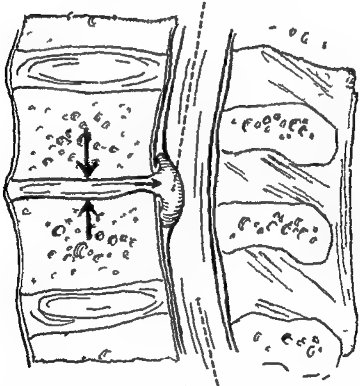

Fig 101 Dislocation of intervertebral disc backward into the spinal canal compressing the spinal cord

If the patient when first seen moves the upper extremities freely, the lesion must be below the cervical region and it suffices to roll the patient over on his face and transport him in that position To place a person with a fractured spine on his back in the usual stretcher is only to invite trouble for reasons already given

The important matter in the treatment of fractures of the spine is,

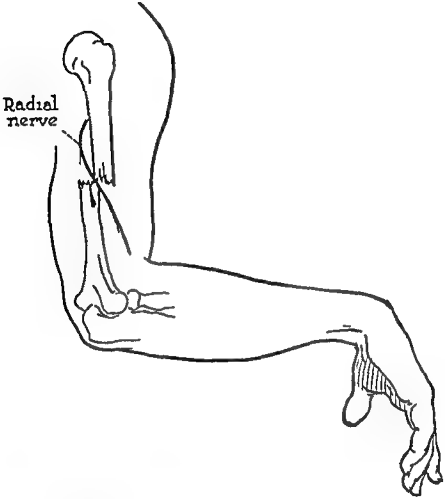

Fig 102 Wristdrop resulting from paralysis of radial nerve inflicted by fracture of the humerus

therefore, to prevent injury to the spinal cord which may be irreparable and leave the patient permanently paralyzed The person who first sees such a patient should remember that any attempt to move him may cause irreparable damage and should go at once for a physician The first aid attendant should not even lift the patient s head to try to shift him into a more comfortable position

THE PERIPHERAL NERVES

Any of the peripheral nerves may be injured in one way or another, especially those of the extremities because of their long and exposed course The problem of first aid in these cases does not differ from that

of fractures and lacerations in general One must stop the hemorrhage and place a clean bandage over any external wound and get the patient to a physician as soon as possible It is very important to prevent infection, since this complicates and delays suture of the nerves involved Success in nerve suture depends on clean end to end anastomosis

17

Wounds of the Mouth, Face, and Neck

LOUIS W SCHULTZ

Modern civilization is passing through a nuclear and electronic age With increased mechanization, physical injuries are increasing steadily Even grown men and women are usually not aware of the menacing dangers to which they are exposed by conditions of modern living until after they or some member of their family have been subjected to accident or injury In fact, trauma is one of the leading causes of death in the younger age group and, in addition, accounts for most of the crippling of our population Facial injuries have increased in severity and frequency with the advances in high speed transportation and complex mechanical and electrical equipment

An oral lesion may be defined as any break or change from normal in the mucous membranes of the mouth This, however, is not all inclusive because many oral lesions also involve the skin surface about the head and neck and may penetrate deep structures also they may involve the bone Although injuries about the mouth and jaw are not in themselves lethal in type they are nevertheless, serious because of hemorrhage due to the extreme vascularity of this region and because of the danger of obstruction to the respiratory passages

The type of injury, the tissues involved the condition and position of the patient determine largely the treatment to be applied The most important element of first aid work in the successful handling of these wounds is to evaluate correctly the extent of injury present and apply the most simple effective treatment As intimated previously the two conditions to be considered first are maintenance of an adequate airway and control of hemorrhage

In rendering first aid clean hands and sterile materials such as gauze bandages and instruments, are essential This equipment is not always at hand and in such a case, quick and accurate thinking coupled with

prompt action is all important This includes intelligent care to prevent infection

Contused or Closed Wounds of the Face Such injuries need little treatment other than an ice pack over the injured part with gentle pressure to prevent blood escaping into the tissues and forming a hematoma i e a blood clot The cold will have a slight anesthetic effect, and will act beneficially in minimizing hemorrhage because of its constricting effect on the blood vessels The cold application should be left on only two to four hours, since a longer contact will tend to devitalize the tissues Heat may then be applied, it causes dilatation of the blood vessels and thereby enhances healing A physician should be summoned to carry out definitive treatment if indicated It may be difficult for the first aid worker to determine whether or not a physician should be called Naturally, if the patient is conscious he should be consulted Because of the close proximity of the face to the brain, it must be assumed that any injury to the face might also affect the brain Evidence of brain injury is determined by methods discussed in Chapter 16

Contused wounds of the face may produce subcutaneous hemorrhage of considerable degree but rarely of the type to cause obstruction of the air passages because the jaw protects the region of the pharynx Perhaps of more importance in contusions about the face is the determination as to whether or not there is a fracture of the upper or lower jaw A fracture of the mandible (lower jaw) is more frequent than fracture of the upper jaw As is discussed later disability will be an important factor in determining the presence or absence of a fracture, since a patient with a fracture of the mandible will not be able to open or close his mouth without severe pain

Open Wounds These may be subdivided into four groups 1, abrasions, 2 incised wounds, 3 lacerated wounds, and 4, stab, penetrating or punctured wounds (See Chapter 5)

These lesions may be serious when vital structures are cut or hemorrhage is violent Bleeding about the head as a rule can be controlled by several means Elevation of the patient s head and body to a sitting position would aid in control of the hemorrhage because of the effect of gravity, but working on a patient in this position is difficult because of failure to obtain proper immobility of that part of the body, moreover, the patient is very apt to faint if he is allowed to remain in this position very long As stated in Chapters 5 and 7 the most effective method of controlling hemorrhage is pressure over the wound with a dressing directed to the bleeding spot with the hand The hands should be clean but one

cannot always stop to wash them if the emergency is urgent It is best not to contaminate the wound more by putting the fingers in the wound A sterile dressing should be used if available, otherwise a freshly ironed handkerchief or towel should be used If simple pressure on a wound of the face does not stop bleeding, an attempt may be made to apply pressure over the artery The blood supply to the portion of the face about the mouth is derived chiefly from the infra-orbital and nasal arteries from above, and the external maxillary (facial) from below Pressure extending from the cheek bone upward and medially toward the midpart of the nose will compress the two former arteries, pressure on the lower border of the lower jaw midway between the angle and symphysis will compress the external maxillary artery (see Fig 31F) Pressure just below the eye obliterating the infra-orbital and nasal arteries, as mentioned previously, will control hemorrhage of the lateral surface of the nose and upper lip Pressure on the lower jaw below the corner of the mouth should control bleeding of the lower lip

When the large vessels of the *neck* (carotid artery and jugular vein) are severed, pressure against the carotid must be accurate (see Fig 31A) and firm, and applied between the wound and the heart This compression is directed posteriorly against the vertebrae and deep muscles of the neck, and medially, but not with sufficient force to obliterate the airway in the trachea Pressure here will serve another purpose, namely, prevent the jugular vein from sucking air into the heart Aspiration of 10 to 15 ml of air into the heart may be tolerated, but more than this is apt to be fatal because the heart chambers fill with air and foam, thus interfering with the pumping action of the heart, blood would no longer be forced into the arteries and the patient would die from lack of oxygen The condition of the patient may quickly become serious because of shock when the carotid artery or jugular vein is cut since loss of blood is so rapid and profuse After bleeding is controlled, all possible effort should be made to get the patient to the hospital as quickly as possible for ligation of the injured vessel and for blood transfusions by a physician

Again the position of the patient, if unconscious or semiconscious is important to prevent aspiration of blood and foreign materials Too much emphasis cannot be placed upon this point the patient should be shifted from the supine to the prone or semiprone position A person in a comatose state may easily aspirate materials loose in the mouth Thus aspiration of blood tooth fragments dental appliances and other foreign bodies has occurred during and after accidents For this reason it is imperative that a thorough search of the oral cavity be made as quickly as

possible This may prevent not only the immediate embarrassment of coughing, strangling, cyanosis, etc, but also the later effects such as abscess formation, atelectasis (collapse of the lung), and pneumonia A tight collar and tie with the head in extreme flexion or extension may result in a fatality due to strangulation if the patient is in a state of unconsciousness, constricting clothing about the neck should be loosened immediately

If a person is found with blood and air foaming from a wound in the neck, it is probable that a laceration of the trachea exists, associated with injury to a major vessel When this combination of injuries is present it is of utmost importance to prevent suffocation resulting from aspiration of blood Action must be accurate and immediate Extension of the neck will enlarge the wound and allow insertion of fingers against gauze dressings to control hemorrhage, trying not to interfere with intake and exhalation of air through the wound If the laceration in the trachea is nearly completely through the structure the patient may not be able to get any air past the injured point by way of the pharynx After hemorrhage is controlled attention is given to the airway If it is obvious that the patient is getting no air into his lungs through the nose or mouth, effort should be made to establish an airway at the point of laceration in the trachea This is necessary because efforts at inspiration will usually collapse the walls of the trachea so that air cannot enter Insertion of an artery forceps into the opening in the trachea and spreading the blades will establish an airway which can be maintained If an artery forceps is not available, such objects as bent hairpins may be tried Naturally, the instruments in a tracheotomy set will be most useful but will rarely be available even at a first aid station As can be imagined, emergency work of this type will be beyond the experience and ability of an ordinary first aid worker It would probably require the skill of a surgeon but if the situation should arise in his absence someone must attempt control of hemorrhage and establishment of an airway otherwise the patient will probably suffocate and drown in his own blood

The lack of cleanliness of the hands and materials used in a case of this kind cannot be censured because the time element is too important a few seconds may mean life or death Our first aid stations and hospitals will have to cope with the possibility of infections that may follow The use of antibiotic drugs will diminish both the incidence and the severity of any complicating infections

Crushing blows (see also p 85) to structures of the nose and face may involve the sinuses, jaws and respiratory passages Such injuries fre-

quently are encountered in automobile accidents or contact with other swiftly moving bodies, and the injury to the head is apt to inflict so much damage on the brain as to produce unconsciousness An individual found unconscious or semicomatose, bleeding from such an injury, may quickly drown in his own blood if not cared for immediately As stated previously, shifting the patient from the supine to the prone or semiprone position will constitute the first action if he is bleeding With such types of injury the hemorrhage will probably be coming from inside the nasal or oral cavity probably outside the realm of control by a first aid worker In such instances the greatest responsibility of the first aid worker will probably be maintenance of the prone position and perhaps maintenance of an airway by holding the jaw forward If the jaw is shattered as might occur in a war wound, it may be possible to get the tongue forward out of the posterior pharynx by the simple maneuver of pressing anteriorly against the ramus of the jaw, as illustrated in Figure 103A It will then be neces-

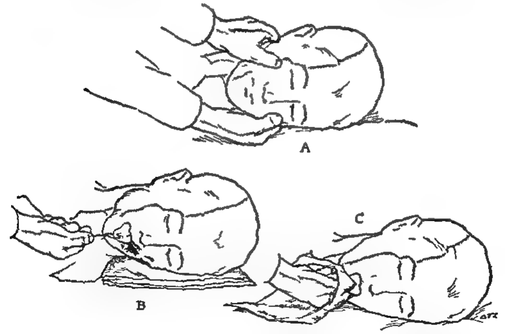

Fig 103 Methods of correcting pharyngeal obstruction due to the jaw falling backward in unconscious or seriously injured patients A the jaw is held forward by pressing anteriorly against the rami B if the patient must be transported quite some distance and obstruction is serious the tongue may be transfixed with a safety pin and pulled forward C grasping the tongue with the fingers covered with a handkerchief is effective temporarily in relieving obstruction

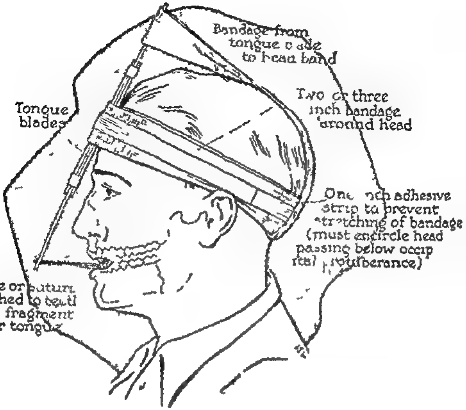

Fig 104 Apparatus for transportation of patient requiring traction of jaw and tongue for maintenance of airway The tongue may be pierced with a suture or safety pin as shown in Fig 103B or wires anchored to teeth or the jaw If teeth are used at least three should be included in the wiring since use of only one would put excessive strain upon it Bending the head well back will also straighten the airway and facilitate easier breathing

sary to grasp the tongue with one's fingers using gauze or a handkerchief to hold it firmly (see Fig 103C) If it is necessary to hold the tongue out in this manner for maintenance of an airway during transportation, it may be advisable to pass a suture or safety pin through the end of the tongue for application of traction (see Figs 103B and 104)

Bleeding from lacerations or injuries deep in the mouth or pharynx should be controlled by digital pressure if possible It is well to wrap the fingers with a towel handkerchief or some cloth before inserting them in the oral cavity, since a semiconscious or excited patient may bite It will probably be necessary to pry open the mouth by insertion of a stick covered with gauze between the upper and lower teeth If bleeding is coming from the depth of the pharynx it will be necessary to use gauze on

a forceps or wrapped around a stick for pressure against the bleeding point Digital pressure on the outside of the neck (against the carotid) may be of assistance in controlling the hemorrhage (See Chapter 7)

Abrasions of the face are not serious from the standpoint of hemorrhage or amount of trauma, but dirt, cinders, and the like, are apt to be ground into the skin, particularly if the wound has been inflicted by contact with the ground Such tiny particles of foreign bodies when ground into the skin cannot be removed by the simple application of soap and water However, they can be removed readily by scrubbing with soap and a brush This is not the function of a first aid worker, since usually some type of anesthetic will be necessary However, he must be aware of the fact that these tiny particles will leave a serious blemish unless scrubbed out They cannot be removed by scrubbing if healing is permitted to take place About the only procedure available for removal after healing takes place is excision of that skin and replacement with skin removed from some other part of the body (skin graft) It may, therefore, be the function of a first aid worker to inform the patient of the urgency of seeing a physician for removal of the foreign bodies immediately after injury

Epistaxis (Nosebleed) Hemorrhage from the nasal cavity may occur spontaneously or following an accident When it occurs spontaneously it usually arises from the septum on either side and is encountered most frequently in children If it occurs in adults, diseases such as hypertension (high blood pressure) or blood diseases (hemophilia purpura hemorrhagica and others) are to be suspected Spontaneous epistaxis in the absence of diseases such as hypertension usually will stop spontaneously without any radical treatment Activity should be restricted and the patient urged to sit down allowing the blood to drip into a basin The age old custom of applying a cold wet cloth to the back of the neck and face may be utilized Cold produces constriction of blood vessels in the tissues at the site of reduced temperature Furthermore it is known to produce constriction at various distant points by reflex action, thereby perhaps justifying the procedure, since constriction of the vessels would tend to decrease hemorrhage Gentle aspiration of ice water into the nasal cavity is sometimes effectual The insertion of a piece of cotton into the nares on the side of bleeding is frequently effective for a time the blood will accumulate in the pharynx and will then have to be allowed to drain out of the mouth However usually a clot forms in the large collection of blood which fills the entire nasal cavity on the affected side When a clot forms against the bleeding point, the bleeding usually ceases Rarely will any treatment more radical than the simple measures mentioned be in-

dicated in first aid work, since the bleeding in epistaxis is usually so mild that there is ample time to call a physician and await his arrival The physician will usually place a cotton pledget saturated with hydrogen peroxide into the bleeding side of the nose after the clots have been removed, or pack it with strips of petrolatum gauze or with one of the newer hemostatic agents, then apply an external nasal splint These should remain in place for about 24 hours and be removed gently lest bleeding be reactivated Simple pressure over the entire nose for a period of five to ten minutes is also effective Any adult having severe epistaxis should be thoroughly examined by a physician for diseases such as hypertension

Epistaxis due to trauma may arise from almost any area in the nasal cavity usually the lateral wall or septum It is very suggestive of a fracture Very commonly it is the cartilaginous nasal septum that is injured Simple measures as mentioned above may be tried Here again the first aid worker will rarely be called upon to resort to major procedures such as packing since the bleeding is usually mild, as in spontaneous hemorrhage, a physician can usually be obtained by the time sterile strips of petrolatum gauze can be acquired by the first aid attendant During transportation the patient should remain quiet, assuming a semiprone position with the bleeding side down

When the methods previously mentioned fail to control the nasal hemorrhage the patient in a sitting position, should be instructed to blow his nose to discharge loose clots With the head tilted slightly backward he closes the uninvolved nostril with his thumb, then inhales through the open nostril and exhales through the mouth and repeats this as rapidly as possible until the hemorrhage ceases The rapid transmission of dry air will quickly control even violent bleeding

Dislocation of the Jaw This lesion is not common but occurs occasionally as the result of accidents or an excessively vigorous yawn A moderate amount of tenderness and pain is experienced in the region of the joint just in front of the ear Usually both sides are involved but occasionally the dislocation occurs only on one side In either case the mouth is held open and cannot be closed attempts to close it are painful If the dislocation is present on only one side the chin will be deflected toward the normal side Bilateral dislocation is characterized by a protruding chin and inability to close the mouth in normal occlusion Although dislocation of the jaw should be reduced as soon as possible after the accident there is ample time to get the patient to a physician Reduction is achieved by wrapping the thumbs with a towel and placing them on the molar teeth of the lower jaw, exerting pressure downward and back-

ward until a definite jump or click is felt when the jaw resumes its normal position Additional traction can be achieved by pressing the chin upward with the fingers The thumbs are wrapped because when the jaw is returned into the joint, there is spasmodic contraction of the muscles which may crush the thumbs

Sprains of the temporomandibular joint are very frequent and become chronic in many individuals in civilian life (See Sprains, Chapter 11) The etiologic factors for this type of joint injury are congenital weakness, yawning extraction of teeth, dental appointments, injudicious opening of mouth under anesthesia or drawing lower jaw forward and upward to straighten the air passage to facilitate breathing and finally, sleeping on an arm or hand under the jaw for several hours

The injured joint is characterized by pain, noise, locking and false motion

Pain is frequently referred to the ear because of innervation (nerve supply)

Noise is due to tension of ligaments on the fibrocartilaginous disc and rapid release of moving parts of the joint

Locking is due to abnormal motion of the cartilaginous disc (same as a knee that locks due to floating cartilage)

False motion is due to relaxed, stretched, or torn ligaments allowing subluxation (partial dislocation)

Temporary relief can be obtained by an Ace bandage placed around the head and holding the lower jaw very lightly The only effective and permanent treatment is obtained by injecting a mild sclerosing agent Intracaine in oil or Sylnasol which produces a tighter capsule and limits the motion of the joint This is to be done by a physician

Fracture of the Jaw Kelsey and Fry of London have offered a classification of fractures of the facial bones as listed below, it appears particularly appropriate for first aid consideration

A Civilian
B Crushing
C Gunshot
D Air Raid

A Civilian fractures are caused by fist fights, falls, kicks etc , and are not accompanied by loss of bone or soft tissue Comminution and shock are seldom seen in this type unless other injuries are present

B Crushing fractures may be caused by automobiles or airplanes crashing at high speed These fractures usually involve both jaws and are

multiple The displacement is often marked, due to the impact and muscle pull Comminution and loss of bone are seldom encountered, but the skin may show intensive trauma and yet little laceration The general condition of the patient is usually poor due to shock produced by concussion of the brain

C Gunshot fractures caused by bodies traveling at high velocity are characterized by comminution bone loss soft tissue laceration, all of which are greatest at the site of exit General condition of the patient is good as a rule unless there is extensive blood loss or damage to the central nervous system

D Air raid fractures while separately classified may very closely simulate either the crushing or the gunshot type This depends entirely on the size and speed of the missile striking the individual The gravel rash i e , dirt driven into the soft tissues together with the severe shock caused by the blast is the most characteristic phenomenon Such injuries are complicated by burns due to one or more factors, which naturally demand a different treatment covered in more detail in Chapter 8

Roentgenographic Examinations X-ray pictures should be made as soon as possible because the roentgenographic evaluation is indispensable in the diagnosis of jaw fractures Of course complete diagnosis must be based on a correlation of the roentgenographic observations with data obtained from the patient s history, the physical examination, and a thorough clinical examination of the involved structures Certain basic views are required for examination of the bones of the face and mandible These should include anteroposterior and oblique views of skull facial bones, and mandible with detailed studies of the temporomandibular joint regions when indicated If fractures of the middle third of the face are suspected films should be taken in the Water s position and supplemented by moderate variation of the technic or with special projections to demonstrate certain structures more efficiently Intra oral x ray examinations with occlusal and periapical films are often helpful

Principles in Treatment Acute trauma may produce either closed or open or comminuted maxillofacial fractures (Fig 105) The objective in treating fractures of the facial bones is to reduce and align the fractured bone segments to restore the original occlusion of the teeth normal function of the jaws and normal anatomic relationships of the face and to hold these bone fragments in apposition until healing has occurred

Frequently in severe fractures of the facial bones there are associated fractures of the skull involving the cribriform plate of the ethmoid bone lesions of the orbit and the cervical spine Drainage of cerebrospinal fluid

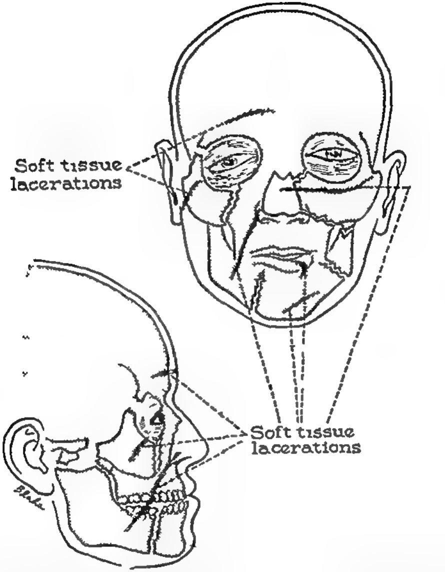

Fig 105 Clinical manifestation of acute trauma in soft tissue lacerations Thorough evaluation of clinical findings will often reveal multiple fractures of the facial bones

from the nose or ear is a diagnostic feature of skull fracture Therefore, a careful examination must be made to detect possible intracranial injury The fact that excellent results are obtained by the early management of fractures in this region in contrast to the disability and deformity resulting from unrecognized untreated maxillofacial fractures makes early diagnosis and treatment imperative

There is a common notion in the minds of many physicians that it is best to defer manipulation and management of the facial fractures in the presence of neurologic symptoms. On the contrary, in the author's 30 years of experience it has been his conclusion that the earlier the treatment is instituted, the sooner the patient's condition will improve and his comfort be restored. Therefore it is strongly recommended that with a fundamental knowledge of facial anatomy (Fig 106) the operator must with extreme gentle care, manipulate and restore the injured parts as soon after injury as possible.

The most simple and effective type of fixation for fractures of the jaws is the best. The more cumbersome the appliance the greater the hazard for

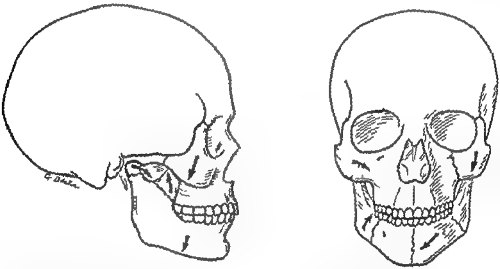

Fig 106 A fundamental knowledge of facial anatomy shows muscular actions in normal occlusion. Arrows indicating muscle pulls causing deformity in continuity of the facial bones.

infection. It is very important that complete reduction and immobilization of the fragments be effected at as early a date as possible since these wounds are almost always compounded. Elastic bands may be used for temporary immobilization but must be replaced as soon as possible with intermaxillary wires (Fig 107).

Fractures of the jaws, both upper and lower, as a rule will need very little first aid. Splinting is an extremely difficult task; perhaps the most important feature in first aid therapy is that a *four tailed bandage should not be applied*, particularly the type in which two of the tails are tied at the back of the neck or head. This type of bandage is frequently advised, but

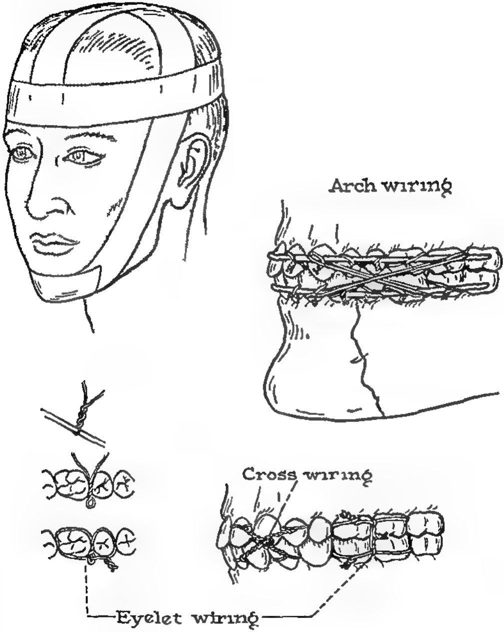

Fig 107 The most simple and effective type of fixation for fractures of the jaws is the best The diagram demonstrates step by step technic of intermaxillary wire fixation

erroneously so, it tends to displace the fragments even more and make an overriding fracture out of a simple one, thereby encouraging the tongue to drop back in the pharynx and interfere with breathing Application of a bandage under the chin extending over the vertex of the head will afford some fixation of the fragments and constitutes about the only type of first aid treatment indicated The lower jaw is so well balanced by muscle action (unless the jaw is badly shattered) that no treatment for support is often better than treatment administered without full apprecia tion of the condition present As stated previously, if there is consider able destruction of tissue as in a war wound, it may be necessary to hold the remnants of the jaw forward or to pull the tongue out of the posterior pharynx Except in such circumstances when severe hemorrhage or res piratory embarrassment exists, treatment may be postponed until a physi cian s services may be obtained the fragments are fixed by the physician usually by wiring the teeth together (see Fig 107)

Fracture of the upper jaw may be partial or total Partial fractures usually are impacted if not the fragment can easily be moved while the balance of the jaw remains fixed Such impacted or loose fragments should not be disturbed treatment is complicated, and should be carried out only by those properly trained Total fractures can easily be recognized by the looseness of the entire jaw there is motion between the jaw and the base of the skull there may be swelling blackness of both eyes and bleeding from the ears nose and mouth The finger should be inserted into the mouth to locate and remove any loose fragments of dental restorations or fractured teeth so that they will not be aspirated

All compound fractures should be given as early attention as possible and by a trained operator so the wounds can be properly cleansed and closed tightly without drainage in almost all cases This will prevent much infection and loss of structure later A wound can always be drained at a later date if an infection develops

Oral lesions for the most part are trivial and uncomplicated This however should not make one discount their importance because this cavity and the nose form a direct passageway to the lungs Obstruction of the airway is of course dangerous Even though not complete or suffi ciently severe to cause death it may cause anoxemia (lack of oxygen in the blood) Although all organs are affected by lack of oxygen perhaps the most serious damage is sustained by the brain in which permanent damage may be inflicted Although relief of respiratory obstruction may frequently be necessary in injuries about the face mouth and neck it will rarely be necessary to resort to artificial respiration If it is needed

the author wishes to recommend the mouth to-nose method The patient s mouth is closed, a piece of gauze placed over his nose, and the patient s lungs distended by blowing through his nose The expired air of the operator contains sufficient carbon dioxide to stimulate respiration of the patient, there is enough oxygen in it to tide the patient over until respiration is re-established, if he can be resuscitated (see also Chapter 13)

First aid treatment of wounds about the face and neck must of necessity encroach on the scalp at times For this treatment see Chapter 16

ORAL HYGIENE The most important single factor in the general care of the patient with a facial injury is oral hygiene In other words oral hygiene is the keynote in the successful treatment of lesions associated with the mouth If it is possible the patient should brush his teeth several times a day in order to remove all white film from the teeth and gums In some instances a nurse should help a patient to maintain good oral hygiene by means of a cotton swab or clean piece of gauze wrapped around a clean finger to massage his gums Physiologic saline solution or alkaline mouth washes are recommended

DIET The second most important factor in the general care is diet and fluid balance Nutritional disturbances may be pronounced and must be considered They become apparent and last through fixation Therefore, the diet should be maintained at a high caloric, high protein and high vitamin level and primarily must be liquid There is enough space between the teeth and around the distal ends of the dental arches to permit the ingestion of adequate liquid nourishment It is, therefore radical to extract teeth to maintain adequate nourishment for a patient with a fractured jaw

PAIN PROBLEM Facial fractures usually produce extreme pain because of abnormal mobility, crepitation, marked displacement of fragments, possible interosseous impaction and pinching of soft tissues and periosteum All of these factors contribute to the pain and discomfort Again the author wishes to stress that the earlier the treatment is instituted the sooner the patient s apprehension will be allayed and his comfort restored It has been my observation that as soon as I reduce and align the fractured bone fragments to normal and immobilize them firmly, the patient is free of pain Not only that but it has helped in the general care of shock hemorrhage, and airway obstruction (in some instances I have avoided tracheotomies) Mild sedation is recommended again depending upon the patient s pain threshold

CONTROL OF INFECTION With the advent of antibiotics and chemotherapy, post traumatic infections are few Patients with facial fractures

which are open, orally contaminated or infected should be given adequate doses of broad-spectrum antibiotics to prevent infection

Tetanus antitoxin or toxoid should be considered and administered if open wounds are apparent True gas gangrene has apparently never been observed in a facial injury

Burns Burns of the mouth are identical to burns elsewhere on the body except, obviously, a sunburn There are slight variations, however, in their treatment Details of the treatment of burns will not be included here because they are presented in Chapter 8

The etiologic factors of thermal, chemical, radiation and electric burns of the mouth hold true, the same as for burns elsewhere The classification of burns into first, second, and third degree also is the same as for the rest of the body

Thermal burns can be subdivided into the extremes of heat and cold on either side of the body temperature When heat is the cause whether it be due to friction or latent heat in an object, the trauma can range from a mild hyperemia to a marked destruction of tissue necessitating a plastic repair at a later date

Chemical burns resulting from acids or alkalies should be neutralized as soon as possible with an agent that will not be destructive to the normal tissue Continuous lavage until one is certain that no more harm will come from the destructive agent, should be carried out very cautiously and thoroughly

Burns of the oral cavity are rare and when seen are usually caused by poisons of the acid or alkali type Burns of the lips may occur with the common flame or hot water burns of the face

The most important factors in the treatment of burns of the mouth are 1, control of pain 2 prevention of shock, 3 reduction of infection to a minimum 4 *active treatment of denuded area to promote growth of* granulation tissue and 5 plastic repair of skin, muscle, and mucous membrane at the proper time

To promote early stimulation of healthy granulation tissue a complete debridement of the burned area as soon as possible is advisable Frequent irrigations with physiologic saline are helpful also Where skin, muscle and mucous membrane have been destroyed, particularly in the upper or lower lip or both it is recommended to allow these parts to heal before a plastic repair is attempted

Burns which destroy the vestibule of the upper or lower jaw and cheek sometimes can be corrected immediately by placing a split skin graft over a stent of modeling compound or acrylic and joining it in

place This, however, can be done only in older and more cooperative patients Burns in babies must be allowed to heal, and correction made subsequently

The typical electric burn in babies destroys the corner of the mouth, involving the skin, muscle and mucous membrane This type of burn should be allowed to heal Very often 50 per cent or more of the orifice of the oral cavity will be destroyed When this wound has healed, it will be found that much of the body of the lip in that region has become fibrotic due to the surge of current through the tissues Every effort should be made to conserve this tissue to reduce the deformity Frequently it can be utilized in the reconstruction, and by proper preparation of flaps and suturing, a good cosmetic result can be obtained

The currently used antibiotic drugs such as penicillin, Aureomycin Terramycin, and others reduce the infection to a minimum and allow granulations to form quickly

The nutrition factor should have some consideration in these patients In most cases a bland liquid or semisoft diet will be in order This can be taken by mouth in some cases with a glass tube or straw In the more severe cases a Levin tube or indwelling catheter passed through the nose should be resorted to This type of feeding may help greatly in preventing many complications that might otherwise arise due to a fluid imbalance infection or disturbance of grafts

In conclusion many of these mechanical, thermal and electric accidents can be prevented by better education of consumers, chiefly in some of the simple principles of physics mechanics and chemistry these principles should be taught to all high school students and to students in teacher training institutions

18

Emergencies of the Genitourinary Tract

JOSEPH H KIEFER AND JAMES H McDONALD

Anatomy The *urinary tract is located on the back wall of* the abdominal cavity It is protected from injury by the abdominal contents in front and by the heavy muscles in the back

The kidneys which produce the urine are two in number and lie on each side of the spinal column just below the lower edge of the rib cage The kidneys are composed of two parts the parenchyma or renal tissue, that produces the urine and the pelvis, into which the urine drains for removal from the kidney

The two ureters are muscular tubes that collect the urine from the pelvis of each kidney and pass downward on each side of the spinal column to enter the urinary bladder (see Fig 108)

The urinary bladder is a single organ located deep in the body cavity and protected by the bones making up the hip girdle It is a muscular saclike structure which acts as a reservoir to collect the urine from the kidneys It will normally hold up to one pint or more of urine without difficulty When the amount of urine in the bladder reaches a given volume the individual has a desire to void and the muscles of the bladder will contract and the urine will be emptied through the urethra

The urethra is a tubular structure extending from the urinary bladder *to the outside In the male it is a long structure opening at the tip of the* penis and is divided into three parts the anterior, the membranous and the posterior urethra In the female the urethra is very short, being only one and one half inches long is of larger caliber than the male urethra, and opens in the upper outer portion of the female genitals

The male genital tract is composed of the testicles and their suspending cords in the scrotum and the prostate glands, located adjacent to the posterior urethra

General Principles of First Aid The organ system as described above is in the main remarkably well protected from injury Treatment from a first aid standpoint is directed toward helping the patient s general con

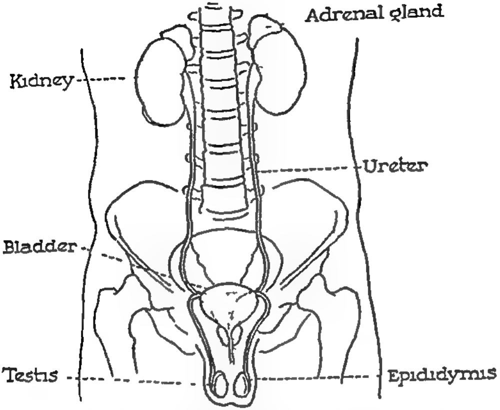

Fig 108 Anatomy of male genitourinary system

dition rather than specific treatment of the genitourinary tract injuries Most of the structures are inaccessible and complete hospital facilities and specially trained personnel are required to treat injuries of these organs

Fortunately there are few true emergencies involving the genitourinary tract Injuries of these organs are infrequent due to the deep internal location which protects them from all but the most severe trauma However, the era of the high speed automobile, the increased mechanization of the farm and of industry may well increase the incidence of genitourinary injuries

As mentioned above, injuries of the genitourinary tract occur most often where there has been violent trauma The most easily recognized indication of injury is the presence of blood in the urine Other external evidence of injury may be absent Injuries to this organ system are always serious and always require hospitalization for complete diagnosis and treatment

Kidney Injuries The kidneys contain a large number of blood vessels

and for this reason do not well withstand blows or puncture The infrequency of injury to these organs is primarily due to their mobile position within a fatty sheath so that they "roll with the punch," and the protection of the heavy back muscles, the lower rib cage and the abdominal contents Injury may be produced by blunt objects striking the kidney area with great force, as in an automobile accident or when the individual falls or is thrown with violence Injury may also occur from bullet or stab wounds

The mechanism of injury to the kidney is through the kidney acting as a bag of fluid transmitting the impact of a blow in all directions Tearing of the kidney tissue and/or the kidney pelvis or the major blood vessels to the kidney results from the increase in pressure in the kidney caused either by the direct blow or by secondary impact against adjacent structures

The most obvious and important sign of kidney injury is blood in the urine

Most often the kidney injury is a bruise or contusion, and while this will cause blood in the urine it will clear up in a short time However more severe injuries will cause severe bleeding with large amounts of blood in the urine and with bleeding into the space around the kidney to produce a mass in the flank If the kidney pelvis is torn urine as well as blood will leak into the space about the kidney

A story of injury from the patient or witness of the accident the presence of shock with a rapid thready pulse pain and tenderness in the flank rigid abdominal muscles with or without blood in the urine, all point to kidney injury Externally there may be evidence of skin damage at the site of the blow or an external skin wound if the injury is by bullet knife or sharp object In many instances these findings are associated with other injuries such as broken bones or bowel injuries Hospitalization of the individual is necessary However if immediate hospitalization is not available 1 Keep the patient quiet place him at absolute rest flat on his back 2 Check the pulse for change in rate (if the pulse quickens and weakens it usually means shock due to hemorrhage) 3 Frequently and gently check the injured side for any increase in tenderness and pain or for any increase in the mass size 4 Have the individual void into a container (still in a flat position) mark containers with the time of voiding and save so that the progress of the blood in the urine can be checked

Ureteral Injuries Ureteral injuries are rarely seen as the result of external injury This is due to the small size and mobility of the organ

and the protection throughout its course by heavy muscles in the back and sides and the abdominal contents in the front

Bleeding in ureteral injury is mild and urine leakage into the tissues after injury does not as a rule produce immediate difficulties Recognition at the time of accident is difficult and generally requires special instruments and personnel to make such a diagnosis Obviously, when ureteral injury is suspected, hospitalization is imperative

Bladder Injuries The most common bladder injuries are perforations and tears caused by direct blows to the bladder region Such injuries are frequently associated with broken bones of the pelvis, which surrounds the urinary bladder The individual who has not passed urine for some time prior to the injury and has a bladder which is distended with urine is more susceptible to bladder injury than if the bladder were empty and collapsed Blast injuries from explosions are especially damaging to the distended bladder whereas the empty bladder is not usually affected by the blast This is especially important because at times of stress and excitement one is apt to disregard the urge to urinate, allowing the bladder to distend with urine

Bleeding is usually not severe in bladder injury The main danger is leakage of urine either directly into the abdominal cavity or into the spaces surrounding the bladder This urine leakage leads to severe infection and if not properly treated will cause death

The story of injury, inability to urinate, bloody urine pain and rigid muscles in the lower abdomen will cause one to suspect a bladder injury Broken bones of the pelvis so frequently associated with bladder injury, add to the suspicion of such injury

The treatment of a bladder injury is always an emergency and the individual should be immediately transferred to a hospital for operation While awaiting transfer to the hospital the usual absolute rest and treatment for shock which commonly is present in this injury should be carried out

Urethral Injuries Injuries to the urethra may be caused by bullet or stab wounds and by external blows They are more commonly associated with straddle injuries when the individual falls astride an object whereby the blow is directed upward between the legs and causes crushing and tearing of the urethra This type of injury leads to bleeding The leakage of urine and blood into the tissues surrounding the urethra produces swelling and a severe bruiselike purplish discoloration of the skin These injuries are extremely painful and cause mild shock Constant pain along the penis and in the area between the scrotal sac and the rectum, with

swelling and purplish discoloration of the skin of these areas plus difficulty or inability to urinate, and a bloody discharge from the penis leads directly to a diagnosis of urethral injury. The treatment is directed toward alleviation of shock, cleansing and dressing of the external wounds, and pressure dressings if the swelling continues to increase. Transfer to a hospital for *immediate treatment* is necessary.

Genital Injuries. Contusions of the penis cause swelling of the tissues and, in more severe injuries, purple-black bruises of the skin, which may spread to the scrotal sac and even to the lower abdominal wall. The treatment is bed rest, ice packs, and an indwelling urethral catheter if there is any interference with urination.

Fracture of the penis occurs with severe injury of the erect organ with a resulting rupture or tearing of the large blood filled spaces. Bleeding into the tissues is extensive with marked swelling, pain, and purple discoloration of the penis and surrounding structures. The treatment is similar to that of contusions; however, if the swelling and bleeding are not controlled, the patient must be hospitalized for incision with evacuation of the blood clots and tying of the bleeding vessels.

Wounds of the penis are rare, usually being due to gunshot or stab wounds and occasionally those inflicted with a razor. Treatment is directed toward maintaining the urine channel (with indwelling urethral catheter), control of bleeding, saving of all skin and tissues, and preventing further infection by covering the wound with sterile dressings.

Scrotal Injuries. Scrotal injury, with or without penile injury, may occur from kicks, blows, straddle injuries, gunshot or stab wounds, industrial and farm accidents, and self mutilation. There may be only mild to moderate swelling of the scrotal sac. However, severe bleeding with marked swelling and purple discoloration, or an actual tearing free of the scrotal sac may occur. In scrotal injuries without a break in the skin but with considerable swelling, the treatment consists of scrotal elevation by use of an adhesive tape bridge across the thighs, pressure dressings, and application of cold packs. In more severe injuries with severe bleeding and laceration, hospitalization is necessary. Antitetanus therapy is necessary because of the introduction of infectious material deep into the tissues as often happens in many of the tearing injuries of the scrotal sac.

The testicles are frequently unharmed, even in the most severe scrotal injury. Severe bleeding may occur from the testicular artery if the testicle is torn free from its cord. This bleeding can be controlled by hand or pad pressure over the upper portion of the scrotum, compressing the testicular cord against the pubic bone of the pelvis. Further treatment is the same as

that for shock, and the prevention of further introduction of infection by covering the injured area with sterile dressings All the tissue should be preserved and the patient transferred to a hospital for further evaluation and surgical treatment

There are certain conditions which may not be directly due to injury but are secondary to existing disease that is accentuated by the circumstances frequently associated with the situation requiring first aid work Emotional and nervous factors associated with catastrophe, as well as exposure with chilling and systemic or local infections, may precipitate acute urinary difficulty

Acute Urinary Retention One of the most common of these situations, and one of the most painful, occurring predominantly in men, is the sudden inability to pass urine Other than the injuries mentioned previously, the common causes of this condition are enlargement of the prostate gland, stricture or narrowing of the urethra acute infections, exposure to cold, long automobile rides, and bladder hemorrhage with blood clot formation in the urinary bladder The patient suffers acute pain and may develop symptoms of mild shock If the retention is of several hours duration, the urinary bladder may be felt as a globular mass in the midline of the lower abdomen

Occasionally relief can be obtained by giving the patient sedatives and a hot bath or by the application to the lower abdomen and genitals of warm moist packs If this fails to initiate the passage of urine the passage of a soft rubber urethral catheter into the bladder under sterile conditions, is necessary This should only be attempted by one who is properly trained in the procedure and with the proper instruments The rubber catheter should be boiled for ten minutes, the penis washed thoroughly with soap and water and the person doing the catheterization should wash his hands with soap and water and wear sterile, rubber gloves if such are available If sterile gloves are not available, the catheter should not be touched with the bare hands but should be held and passed with a sterile forceps instrument Lubrication of the catheter with sterile mineral oil glycerin or water will facilitate passage After the catheter has been passed into the bladder and the urine removed, it is then fixed in place with adhesive tape until the patient can be transferred to a hospital If a catheter cannot be passed or is not available the patient should be immediately transferred to a hospital

Renal Colic This condition which may occur at any time or any place is usually caused by a stone in the kidney or the ureter There is extreme pain over the back and flank which radiates around the flank

into the groin, and into the scrotum in men, the vagina in women The urine may contain varying amounts of blood or may be clear A hot tub bath with sedatives will give considerable relief and should be followed by applying warm, moist packs a hot water bottle or heating pad to the affected side Further definitive evaluation should be performed by a physician

Paraphimosis This occurs in the uncircumsized male and refers to the condition produced when a tight foreskin is retracted or pulled back behind the head of the penis and cannot be returned to its forward position Swelling of the retracted foreskin occurs with a ringlike constriction behind the head of the penis This also produces swelling of the penile head and makes replacement of the foreskin a difficult procedure Manual replacement of the foreskin is carried out by facing the patient, placing both thumbs on the head of the penis, with the index and middle fingers of each hand at the point of the foreskin constriction and then pushing the head of the penis through the constriction with the thumbs while at the same time pulling the constricted foreskin over the head of the penis with the index and middle fingers If this maneuver fails the patient should be attended by a physician as gangrene may develop if the constriction is not relieved

In summary many conditions of the genitourinary tract as seen in the first aid station require hospitalization physician care and operation However proper first aid treatment can be of greatest importance in improving the future course of the patient s convalescence as well as giving the patient a considerable degree of immediate comfort

19

Injuries to the Hand

JOHN SCHNEEWIND

The basic principles of good first aid treatment of wounds anywhere on the body apply to wounds of the hand, however, because of the highly specialized function of the hand, it is even more important to obtain the very best results possible by avoiding infection and additional tissue damage which lead to stiffening and loss of the delicate hand movements

GENERAL PRINCIPLES

It is axiomatic that the person rendering first aid must be sure that the life of the injured patient is not being threatened by an obstruction to his airway or severe hemorrhage He must first treat the patient as a whole rather than being diverted to a local injury of the hand, leg, or other part Examination of the injured patient should proceed systematically from a general inspection to local areas of injury Cardinal points of the initial inspection include the following

1 *Is the patient breathing?* The examiner must be sure the tongue is forward and that vomitus, blood, or mucus are not blocking the airway
2 *Is the patient bleeding?* Immediate control of hemorrhage by a clean pressure dressing is mandatory
3 *Is the patient in shock?* If so he must be kept recumbent Remember that in injured persons, *hemorrhage* is the most common cause of shock When it becomes necessary to transport the patient for definitive care, this should be done with the utmost gentleness and with injured parts immobilized as thoroughly as possible

CARE OF THE HAND INJURY

Good first aid treatment of hand injuries will include careful adherence to the following basic principles 1, protection against added infection, and 2, immobilization in a position of function

1 *Protection against infection* The best way to protect the wound is to cover it with sterile gauze squares If such a dressing is not available, a freshly laundered handkerchief or small towel may be used After the wound is covered a bulky pressure dressing should be applied The purpose of the bulky dressing is to control bleeding minimize swelling and keep the injured parts at rest The pressure should be moderate as a very tight dressing may constrict blood vessels and cause added damage to the hand The fingers should be separated from each other and kept in a natural curved position
2 *Immobilization in the position of function* The purpose of immobilization is to minimize further damage to the hand after injury of the soft tissues and bones The position of function (Fig 109) usually maintains the most favorable relation of bone ends and lacerated soft tissues and will prevent muscle contractures and joint stiffness often present after immobilization in the flat position

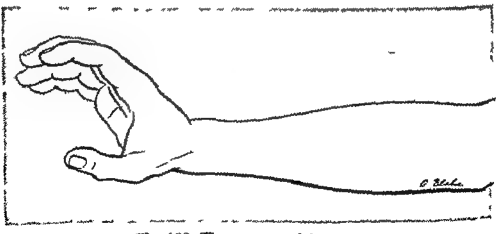

Fig 109 The position of function

Ideally then, the best treatment of the injured hand is immediate wound protection with sterile gauze, application of a bulky dressing with moderate, evenly distributed pressure, and immobilization in the position of function by splinting Such a dressing is illustrated in Figure 110 Aluminum strips are ideal for splinting as they can be bent to the desired shape and are light in weight Wooden splints or plaster of paris may

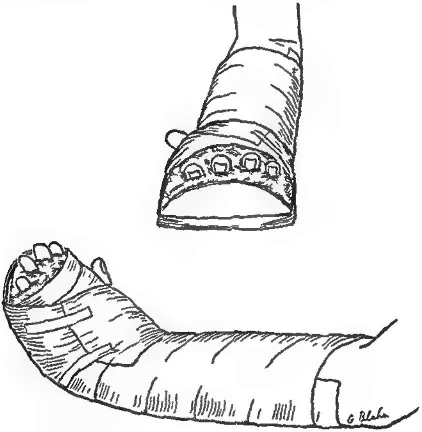

Fig 110 Compression dressing of the hand

also be used Additional immobilization should be obtained by application of a sling

Certain common errors in first aid treatment should be avoided It is extremely important to *avoid putting anything into the wound*—*this includes antiseptics instruments and gauze It is best not to attempt to clean the skin close to the wound at all*, however, it does no harm to wash the surrounding areas with soap and water provided the wound itself is always protected with a sterile pad It follows then, that any preliminary attempts to explore a hand injury should be avoided Defini-

tive treatment should begin when the patient has arrived at a hospital where operating room facilities with complete equipment, adequate anesthesia, and surgically aseptic technic are available

Treatment of Specialized Injuries There are certain injuries for which slight alterations in the basic first aid treatment may be advantageous

1 *Chemical burns* Removal of the chemical by thorough irrigation with water is advisable
2 *Thermal burns* These as well as chemical burns should be treated exactly like wounds, i e with coverage by a dry sterile dressing and immobilization Application of thick coatings of ointments or petrolatum should be avoided
3 *The mangled hand* Severe crushing injuries with skin avulsion and multiple fractures are best treated with the Universal Splint (Fig 111) The splint should be covered with a sterile dressing and the hand then gently placed over the splint Any tissue not actually separated from the hand should be retained A bulky, pressure dressing should be applied following which the extremity should be elevated

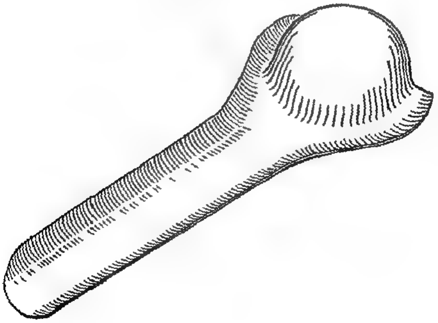

Fig 111 Universal splint (Mason)

4 *Wringer injuries* Injuries due to compression by rollers may be very serious, even if the skin is not avulsed A pressure dressing should be applied at once followed by immobilization and elevation of the extremity

IMMEDIATE HOSPITAL TREATMENT

It is important for all who may be called upon to render first aid for the injured hand to understand the principles of early definitive treatment After the patient has arrived at the hospital he must receive a general physical examination in order that correct priority of treatment be established This is especially true for patients with multiple injuries or for elderly patients It will be necessary also to summon sufficient personnel and have the proper facilities prepared

Personnel In addition to a surgeon experienced in the treatment of hand injuries there must be available operating room nurses, an anesthesiologist, and assistants for the operating surgeon

Facilities Full operating room facilities are required Operations on the hand are major ones requiring strict aseptic technic, including masks, gowns drapes and other material A full supply of instruments good lighting, and a pressure cuff to insure a bloodless operating field must be available General anesthesia usually will be required

Preliminary Examination A preliminary examination is necessary to evaluate the hand injury before taking the patient to the operating room, but this examination must never be careless with respect to asepsis, or cursory with respect to the extent of injury The preliminary examination should be done in a clean area personnel should be gowned and wear caps and masks, a few sterile instruments and bandages should be ready to protect the wound against further contamination After determining the details of when and where the injury occurred and the extent of first aid treatment rendered, the wound itself must be evaluated as to the type, i e , incised contused crushed etc and the degree of contamination present Assay of the structural damage includes

a Extent of skin loss
b Major bleeding
c Evidence of tendon laceration by testing motion
d Assay of nerve damage by sensory and motor tests
e X ray for bone and joint injury

Operative Treatment. Principles of proper operative technic include

a Thorough soap and water preparation of the entire hand and forearm with the wound protected
b Meticulous draping and a bloodless field
c Thorough wound cleansing and removal of foreign material and any devitalized tissue
d Ligation or repair of severed blood vessels
e Repair of damaged nerves
f Repair of divided tendons if not contraindicated by long duration since initial injury
g Adequate skin coverage with skin grafts if necessary
h Reduction of fractures and immobilization in the position of function
i A carefully applied bulky, protective dressing with moderate even pressure
j Administration of antibiotics and tetanus antitoxin or toxoid as indicated

20
The Feet

CHARLES B. PUESTOW

On first thought it might appear that devotion of an entire chapter to lesions of the feet requiring first aid treatment is allocating too much space to such a subject. However, there are no more minor ailments that can be so incapacitating as those of the feet. This fact is always re-emphasized among military personnel, although the problem is always present among civilians but not concentrated sufficiently to be impressive. Therefore, it does not appear inappropriate to devote considerable discussion to various aspects of this subject, particularly since so many of the lesions are acute ones requiring first aid treatment and not complicated surgical therapy. As long as military training of at least a fair number of our people seems to be with us indefinitely, it appears to be more than justifiable to devote considerable attention to the numerous conditions discussed in this chapter.

Commercialization and indiscriminate use of so-called arch supports, bunion pads, corn plasters, solutions for "dissolving" corns, and various powders and ointments have tended to create in the public mind the impression that the use of these sundry products is the answer to all foot ailments. As a result of this, many individuals come to see the orthopedic surgeon with disabilities of the foot far more severe than would have been the case if proper treatment had been instituted early.

ANATOMY OF THE FOOT

Perhaps more so than in any other part of the body, a knowledge of the structure of the foot is necessary in order to understand the methods of treatment employed.

The foot is composed of twenty-six bones in sections. The hindfoot or *tarsus* is made up of large massive bones, the os calcis (calcaneus) and astragalus (talus), to take the pounding with each step; the forefoot, or *metatarsus*, is the take-off point which ends in the toes, or *phalanges*

Mechanically the foot has two functions, namely to *support* the body weight and to *act as a lever* to elevate and propel the body in walking and running The arch structure gives the foot elasticity and aids in absorbing *some of the shock which would otherwise be transmitted to the body*

The *arches* of the foot are formed by bones which are fastened together and supported by ligaments, tendons, and muscles Today it is generally accepted that the ligaments maintain the arches while the muscles maintain balance through their tendons raising the arch and intermittently dropping the foot back on the ligaments for support of the arches These arches are not rigid but have varying degrees of elasticity necessary for the proper functioning of the foot

There are various arches described, but for first aid purposes we will consider only two the *longitudinal arch* which extends in the direction of the long axis of the foot, and the *anterior* or *metatarsal arch* which is confined to the forefoot and extends in a transverse direction across the heads of the metatarsals

The longitudinal arch consists of inner or *medial* and outer, or *lateral* pillars Both pillars rest on the os calcis posteriorly The medial pillar is much higher and rests anteriorly on the first and possibly the second metatarsal heads, while the outer portion is almost flat and rests in front on the heads of the fourth and fifth metatarsals This arch serves to join the hindfoot with the forefoot at the midtarsal joints This juncture is always one third of the distance from the tip of the heel to the tip of the great toe The longitudinal arch is maintained by the plantar ligaments and the plantar fascia Within this arch are housed the blood vessels nerves and muscles That there is sufficient room for these structures to be free is all that is important

The anterior arch is formed by the heads of the five metatarsal bones and is rather shallow It becomes flattened and disappears upon weight bearing but resumes an arched form when the weight is removed Because of this many do not consider this to be a true arch

Movements of the foot occur through the various joints By a combination of movements through the use of two or more joints, various positions of the foot may be assumed

The *ankle joint* is formed by mortising an irregularly shaped bone, the ankle bone (astragalus) into a groove formed medially by a downward projection from the medial side of the tibia (medial malleolus) and laterally by the distal end of the fibula (lateral malleolus) This joint is hingelike in character and allows the foot to bend upward (dorsiflexion)

or to be dropped (plantar flexion) It is the astragalus which receives the body weight and transmits it to the rest of the tarsus

The subastragaloid joint lies between the lower portion of the astragalus and the upper border of the os calcis This joint, in connection with others, permits side to side motion (inversion and eversion) of the foot on the leg

The *midtarsal joint* lies immediately in front of these two bones and permits a limited amount of movement and also adds elasticity to the foot

The *metatarsophalangeal joints* and the *interphalangeal joints* of the toes provide motion in a manner similar to the corresponding joints in the hands and fingers The toes, particularly the great toe when functioning normally add power and smoothness to the gait

AFFECTION OF THE ARCHES

By far the greatest proportion of painful feet is due to a change in the arch structure with a resulting abnormal distribution of pressure upon the foot

The direct cause for painful feet may be that of strain or trauma by A, excess weight as in obesity, B, excess exercise as in long walks or marches on the untrained foot C, excess standing D, abnormal positioning of the foot, E, poor posture and gait F, poor shoes and support, and G, actual injury to the foot However these are often superimposed upon some deep seated condition as 1 hereditary errors in muscular, neurotrophic, or osseous structures (such as spina bifida, accessory bones, fusions and shortening of the first metatarsal), 2, infections producing fibrosis locally and toxic relaxations of supporting structures at a distance, 3, arthritis metabolic or traumatic 4, toxic states and 5, relaxing of ligaments after prolonged illness

The most common type of flatfoot is the so called *weak foot* or *flaccid (flexible) flatfoot* In this condition the longitudinal arch is flattened, the forefoot is abducted and the heel turned outward (everted) In the early stages this happens only on weight bearing, while at rest the arch may be normal and all movements of the foot may be carried out As the condition becomes chronic with continued foot strain and stretching of the capsules and ligaments on one side and contractures of the opposing structures occurring on the other the deformity becomes more and more fixed even at rest (*rigid flatfoot*) If these changes occur in childhood as the bones of the arches are forming there are few if any symptoms from this type of foot except with stress or injury

The *peroneal spastic flatfoot* is considered to be the result of congenital anomalies of the tarsal bones on the basis of studies of recruits in the Canadian Army by Harris and Beath They found an astragalocalcaneal bridge (fusion of the accessory os sustentaculi to the astragalus) Previously, a calcaneonavicular bar (fusion of the anterior process of the calcaneus to the navicular) had been observed and associated with severe rigid flatfoot In these conditions the peronei become shortened and spastic, placing the plantar fascia under strain If the fascia maintains its integrity, the whole foot is everted and the strain directed to the gastrocnemius and soleus muscles If the fascia is weak and stretched, the forefoot first abducts, and later with progression, the heel is pulled out and *the heel cord shortens When the foot becomes fixed in this position it is* called a rigid flatfoot It may or may not be painful but neither does it function well

Acute foot strain may have its inception in any one of the several ways mentioned It is manifested by pain, swelling and inability to bear weight With *chronic foot strain* the lower extremity is fatigued, tiring easily after standing or walking a short time Discomfort, aching and a burning sensation of the arches of the feet are among the first symptoms of foot strain The strain may be felt on the medial side of the ankle The aching may extend upward to involve the calves of the legs as the result of strain on the stretched and bowed gastrocnemius and soleus muscles Cramps occur in the leg especially at night and the feet often swell as noted by the patient when the shoes become tight On examination, the foot is seen to turn outward and the weight rests on the medial side of the heel *If the condition is allowed to progress, the feet will feel cold and* numb as a result of impairment of the circulation (due to loss of the protection of the neurovascular structures by the longitudinal arch) There is marked tenderness under the arch over the plantar fascia with trigger points under and in front of the lateral malleolus Callosities form at the new pressure sites *under the metatarsal heads in direct proportion to the* strength of the plantar fascia The weaker the fascia the greater the abduction, with increasing callosity formation under the head of the first metatarsal to a point where the pressure site moves back under the tarsal navicular As this [illegible]s, the gait assumes a slouching shuffling character

An apparent fl[illegible] may be perfectly painless due to fixed contractures and bony dev[illegible] in this position whereas a foot with normal anatomic app[illegible] [illegible] because of strain on ligaments, which may [illegible]

Treatn[illegible] of

normal mechanical relationships in the foot This is done by restoring the strength and tone of the muscles It must be remembered that the only indication for treatment of flatfoot is pain However, prophylactically, proper foot function (including weight reduction and correct posture) is the goal to be sought rather than correction after symptoms appear

In the acutely painful flatfoot, *bed rest* with as complete relief from weight bearing as possible should be insisted upon Application of *local heat* in the form of hot soaks and baking or alternate hot and cold baths (*contrast baths*) and *massage* may be used to relieve pain If prompt relief of pain is not secured by these measures, the injection of Novocain and hydrocortone into the tender areas or trigger points may give relief When the tenderness and swelling have disappeared, the foot should be strapped, holding the foot in inversion and supporting the longitudinal arch for walking

The patient may then be allowed up with progressively increased weight bearing and activity The subsequent treatment is the same as that for a chronically painful flatfoot Here bed rest is usually not necessary A *correctly fitting shoe* is essential The shoe should have a straight last, extended counter and the medial border of the heel prolonged forward (Thomas Heel) with a slight medial elevation of one-sixteenth to one-fourth inch Enough room should be allowed in the front portion so that the toes are not constricted The arches should be supported by firm felt or other suitable padding material (not rigid or too resilient) fitted to the individual foot, depending upon the specific requirements Experience has indicated that this should be done by a physician or by the intelligent patient under his doctor s guidance

It is occasionally necessary to resort to forcible overcorrection of the foot under anesthesia and immobilization in a plaster cast The same treatment as in a flexible flatfoot is then prescribed In extreme cases it may be necessary to utilize various soft tissue and bony operations

METATARSALGIA

The term metatarsalgia has been used to denote pain in the region of the anterior arch Many orthopedic surgeons and anatomists maintain that there is no arch in this area, since on pressure the heads of all the metatarsals touch the ground and bear weight, but there is some question as to what weight each metatarsal head bears in a theoretically normal foot A weight distribution of two sixths under the first metatarsal with one sixth under each of the second third fourth, and fifth metatarsals

has been theorized The causes of disturbances in this part of the foot are the same as those of the longitudinal arch Anything which will throw unusual stress on the forefoot can produce pain Therefore it is frequently found in 1 Women wearing narrow, high heeled shoes in which there is introduced the aggravating factor of dorsiflexion of the toes in order for them to come down flat on the floor Thus, the small flexor muscles of the toes are stretched or the toes hammered and the circulation impaired resulting in degenerative changes and pain 2 The foot with high longitudinal arch (as a *clawfoot*) 3 Shortening of the Achilles tendon with an intact strong plantar fascia, throwing an excessive proportion of the forefoot weight on the head of the first metatarsal 4 Shortening of the first metatarsal All of these are possible causes of disturbances of structural relationships leading to unequal stress with ensuing distressing symptoms These are static changes in which the metatarsal heads are allowed to spread, called *relaxation metatarsalgia* or are crowded, called *compression metatarsalgia* In the latter the plantar digital nerve is compressed or irritated, frequently developing a radiating painful neuroma as it passes the heads of the metatarsals usually between the third and fourth It is also known as Morton s toe Metatarsalgia may also result from trauma and inflammation of this area whether of bacterial or metabolic (arthritic) origin Symptoms of the relaxation metatarsalgia are those of strain in the ball of the foot with a constant burning toothachelike pain under the metatarsal heads Callosities appear under the heads of the metatarsals carrying more than their proportionate share of the weight The symptoms of plantar digital neuroma may appear acutely with a step which twists the forefoot Early distress may be spasmodic but soon becomes constant if treatment fails The burning pain begins under the metatarsal heads radiating into the toes supplied by the nerve Weight bearing aggravates the pain so that the patient must stop, remove the shoe, and massage the toes and foot to relieve the pain

Relief of pain is of primary importance Rest and freedom from weight bearing should be followed by physiotherapy and corrective exercises Shoes redistributing the weight so that each portion of the foot bears its proportionate part are necessary A straight last rounded box toed, with a firm well fitting shank and a heel of moderate height should be worn (one and one half to two inches for women one inch for men) The rigidity of the shank depends on the degree of involvement of the longitudinal arch Pressure on the metatarsal heads is relieved by felt or other carefully fitted resilient padding placed in the shoe just behind the metatarsal heads or occasionally by a metatarsal bar in the same relative location on the

sole of the shoe This may be made of leather, rubber, or metal Manipulation and sometimes the application of a plaster cast may be required A search should be made for foci of infection or constitutional disturbances which may be responsible and if present should be eradicated or corrected

MARCH FOOT (MARCHING FRACTURE OF THE METATARSAL BONES)

Infrequently in civilian life, and with much greater frequency in military service, there occurs a fracture of a metatarsal bone, usually the second or third, with no history of a single severe injury, but following long and repeated foot strain under the stress of unusual exertion, as in marching and the trauma (injury) occasioned by weight bearing

Various theories have been advanced as to the cause, but the pathogenesis is still not clearly defined Continuous minimal mechanical insult (*microtrauma*) piling up beyond the ability of the bone to bear this strain is the immediate cause In the majority of cases, however, the metatarsal strength has been reduced by several factors such as inflammation of the bone (*periostitis*) or of the muscle (*myositis*), disturbances in circulation (*ischemic changes*), relaxation of the muscular and tendinous support of the foot as in a flatfoot, relative shortening of the first metatarsal throwing added body weight on the adjacent metatarsals, and following certain infections

The onset may be abrupt, with a sudden, severe pain at the site of the fracture, or there may be a complete absence of symptoms at the time the fracture occurs As a rule, the course is insidious, the individual becoming conscious of a discomfort and burning pain on the plantar surface of the forefoot gradually increasing in severity This is present when the body weight is borne, and absent in most instances while at rest, although it may be constant To lessen the amount of weight on the affected foot the individual begins to limp There is an exquisite tenderness localized to the fracture site In very mild cases a swelling over the dorsum of the foot is present while in more severe cases the plantar surface also becomes involved This disappears when the foot is elevated and put at rest Unlike most fractures crepitus cannot be elicited

The diagnosis is confirmed by an x ray, but in the early stages this may be difficult since the fracture line is poorly defined and often is incomplete After two or three weeks however, a profuse amount of callus is formed and the fracture line is usually more pronounced This is especially true if the foot has not been immobilized

If the case is very mild, rest and the application of a fitted arch support in a stiff shanked shoe may be all that is necessary in *treatment* If the first metatarsal bone is shorter than the second, the arch support should be fitted slightly high behind the head of the first metatarsal

In severe cases the foot must be immobilized in a plaster cast extending from the toes to the knee and kept in the cast for three to six weeks This should be followed by physiotherapy, graduated weight bearing, an arch support and metatarsal bar as the need is indicated

PAINFUL HEELS

Pain in the region of the heel may be due to involvement of either the soft tissues or the bone, or both The etiologic factors are *trauma* caused by actual injury or poorly fitting shoes, *infection* which may be either local or general *static defects* such as a flatfoot, *metabolic disturbances* such as various arthritides and *anomalies* in the structure of the foot with strain and secondary periostitis at the origin of the plantar fascia

Bursitis There are three principal bursas about the heel The *retrocalcaneal bursa* lies between the Achilles tendon and the posterior surface of the os calcis immediately above the insertion of the tendon Inflammation of this bursa is usually caused by trauma due to pressure from the shoe or by infection and manifests itself by pain on motion and localized tenderness A superficial bursa between the Achilles tendon and the skin (*retroachilleal bursa*) is sometimes present, and bursitis here is most often due to irritation from a tight-fitting shoe The treatment consists of rest and the application of heat If the bursa is fluctuant aspiration and the injection of one fourth to one-half ml of hydrocortone into the sac followed by a tight dressing may be indicated Elevation of the heel using a felt pad and sometimes the removal or splitting of the back of the shoe to relieve the pressure follows the emergency treatment If the inflammation does not subside it may be necessary to incise or resect the bursa

A bursa may form on the inferior surface of the heel (*subcalcaneal bursa*) most frequently centrally and it may be over a bony spur in the origin of the plantar fascia The bursitis or fascitis is often responsible for the pain attributed to the exostosis A felt pad hollowed out in the center placed under the bursa relieves the pain if there is a bursa Otherwise correction of the strain on the plantar fascia is required for relief Excision of the bursa in addition to the spur is essential for cure when surgery is resorted to

Tenosynovitis Inflammation of the Achilles tendon and its sheath may be caused by injury, infection, or a strain, such as produced in walking uphill, in which case the foot is dorsiflexed, stretching the tendon It is symptomized by acute local pain, considerable disability, crepitus (grating) of the tendon on movement, and swelling behind the malleoli It is treated by rest, elevation of the extremity, the application of heat in the form of moist dressings to the tender area, and the injection of hydrocortone into the tendon sheath When the pain is gone, the heel of the shoe should be elevated by means of a pad In this way, the tendon is relaxed by not allowing it to stretch its full length Strapping of the ankle for a short while is also beneficial It may be necessary to remove the counter of the shoe to relieve pressure on the tendon This condition seldom occurs in the other tendons of the foot

Rupture of the Achilles Tendon Amazingly enough, this condition may be very easily overlooked due to the power of plantar flexion of the posterior tibial and peroneal muscles However, they are not strong enough for the patient to stand on his toes Also, the incomplete rupture of the tendon may easily be overlooked due to its extreme range of motion carrying the point of injury a considerable distance from the bruise or laceration of the skin In the absence of treatment, a secondary rupture may be incurred as a result of ensuing degeneration and/or mild trauma Partial or complete rupture of this tendon occurs usually at its narrowest part frequently as a result of trauma This may be a much repeated fairly mild trauma with resultant degenerative changes in the tendon at its insertion or involvement of the tendon by some disease process with rupture occurring on sudden violent strain, such as landing on the strongly extended foot with the full body weight, especially on falling quite a distance A projectile or cutting instrument may sever the tendon A sudden severe pain occurs the foot is dorsiflexed cannot be extended (plantar flexed) or at least only partially a gap can be seen or felt at the site of the rupture, and the disability is at once apparent Tenderness and swelling increase with time In a matter of hours the defect in the tendon may be hard to detect, and the pain may be so severe that the patient can make no effort to extend the foot Suture of the tendon ends should be done immediately and protected in a plaster cast for six to eight weeks Partial rupture, if the symptoms are not pronounced or if it is not seen until late may be treated by rest elevation of the heel by means of a pad, strapping the ankle or application of a cast

Calcaneal Spurs These bony outgrowths usually appear on the inferior medial aspects of the os calcis Their production has been attrib-

uted to both focal and general infections, trauma, static defects, metabolic disturbances, and a short plantar fascia Large spurs are frequently present but may not produce symptoms The onset is usually gradual, with *increasing pain along the medial border of the os calcis, or at the attachment of the plantar fascia* The pain may be acute if a periostitis is present Walking on the ball of the foot relieves the pain

Treatment includes finding and removing foci of infection, rest keeping off the feet and heat After the pain and tenderness subside, proper shoes should be prescribed A rigid shank, supporting the longitudinal arch is better than a flexible one A felt or rubber heel pad with hollow center will relieve pressure on the involved area Rubber heels are better than solid leather If there is associated arthritis, diathermy may be of some value Injecting the tender area with saline solution, Novocain, or hydrocortone often helps X-radiation therapy in small doses may be of value in acute cases Operative procedures, to be resorted to only as a last measure include resection of the spur and the bursa usually associated with it Removal of the spur without the bursa will not be curative If the plantar fascia is tight it should be stripped loose from the os calcis

Periostitis Inflammation of the bony covering (the *periosteum*) of the os calcis may occur at the attachment of the Achilles tendon the lateral or the inferior surfaces Irritation from the shoe, infection, or trauma may be the cause Localized pain and tenderness and swelling over the involved area are the principal symptoms The treatment is essentially the same as that for a bursitis, with rest, heat, and relief of pressure being indicated

AFFECTION OF THE SKIN AND TOENAILS

Athlete's Foot (Epidermophytosis) This disease, which is caused by fungous types of bacteria is extremely common The fungi are now considered to be more or less common inhabitants of the skin, invading it whenever the resistance is lowered Fungi are known to infest and to propagate best in warm, alkaline moist areas Thus, the foot in a shoe provides a rather ideal environment for trycophytotic infections, and occasionally the fingers and other parts of the body are infected

The primary lesions are tiny blisters (vesicles) which itch and burn This causes the victim to rub and scratch the area breaking the vesicles, spreading the infection by means of the serum infested with numerous fungi to adjoining and distant areas The small ulcers left by the blisters soon become secondarily infected Maceration of the skin is a frequent

complication particularly between the toes if open ulcerations and fissures are present Secondary infection occasionally is severe enough to develop a lymphangitis with red streaks extending up the leg The disease may occur at any time but is most common in the summer (hot and humid), especially in people who are active on their feet Soldiers are particularly subject to this condition as they live under ideal conditions for contracting and developing the disease

Prophylaxis should be practiced and foot hygiene is extremely important as is the care of shoes and stockings (See Care of the Feet)

Treatment starts with redoubling the hygienic measures for the care of the feet Direct treatment includes staying off of the feet as much as possible or entirely if the ulcerative stage spreads much beyond the webs of the toes Application of a heavy metal antiseptic or gentian violet to the blisters or the resulting ulcers will usually stop their spread Among the many remedial agents are potassium permanganate (1 to 9 000 solution) soaks daily and local application of half strength Whitfield s ointment Some of the antibiotics may be helpful

Bunions This is thought by many laymen to be an involvement of the skin similar to a corn It is the term used to describe a bursitis on the medial aspect of the great toe at the metatarsophalangeal joint It is rather uncommon for simple bursitis to cause distress for long Generally, after a number of years of recurrence of symptoms there is lateral deviation of the great toe (*hallux valgus*) with either, or both, arthritis of the first metatarsophalangeal joint and/or an exostosis of the medial aspect of the head of the first metatarsal under the bursa The principal etiologic factor is short pointed shoes Prophylaxis and treatment call for the wearing of shoes large enough to prevent pressure During the acute stage the side of the shoe over the bunion may be cut out, and sometimes a wedge of felt or lamb s wool placed between the first and second toes will assist in straightening the great toe and relieving the medial pressure on the first metatarsophalangeal joint Surgical removal of the exostosis may be indicated in advanced bunions The bursa should be resected only if it is calcified and thickened Special procedures are required if an arthritis or hallux rigidus fail to respond to conservative measures

Blisters There are two schools of thought on the treatment of blisters One is to keep them closed the other is to open them and treat them as an open wound immediately The first method if successful will require the patient to be off his feet for a much shorter period of time Treatment of all blisters requires surgical cleansing and preparation of the entire area If the blister is tense and thin walled drainage through a small border

puncture is indicated in the closed method The application of tincture of benzoin to the blister cover whether drained or not will, with a thin petrolatum pressure dressing often lead to resorption of the serum and re attachment of the epithelium to the underlying bed as a skin graft

If the blister is accidentally broken or so large that it is very likely to be broken and the epithelial bleb displaced, the open method of treatment is indicated After surgical preparation of the area, the raised skin is completely removed and a thin petrolatum pressure dressing applied No matter which method of treatment is used, signs of infection must be watched for

Ingrown Toenails Short, pointed shoes, tight stockings, and improper trimming of the nails cause the margin of the nail to turn down and to be come imbedded in the nail groove The soft tissues pinched between the nail and the side and sole of the shoe are soon penetrated and become infected Proper shoes and hosiery and cutting of the nail straight across will prevent this condition Insertion of cotton under the nail edge may cause the nail to grow above the skin margin If diffuse infection occurs, all or part of the nail should be removed

Miscellaneous Affections *A corn* is an abnormal increase in the horny layers of the skin, compressed to form a thickened cone-shaped mass, which when pressed upon from the outside, impinges upon the small nerves in the body of the skin producing pain and disability in the foot It is caused by pressure and the friction of the shoe against the skin, it occurs at the sites of greatest pressure as on the dorsal aspect of the toes or on the lateral side of the fifth toe Frequently there is an associated deformity of the foot, such as a hammer toe, in conjunction with a high arched foot Both prophylaxis and treatment call for proper shoes and hosiery, and gait correction for prevention and cure alike Removal of the pressure and correction of the deformity will often cause spontaneous separation of the corn Removal of the corn is accomplished by softening it with daily hot soaks or plain petrolatum, followed by scraping of the softened layers of skin and keeping it level with the skin The use of a scalpel or razor blade is best restricted to the hands of a surgeon For scraping, however an emery board or pumice stone is relatively safe in the hands of the patient Covering with adhesive will reduce rubbing Various preparations containing salicylic acid are used, but these should be prescribed by a physician and used cautiously on the corn alone

Soft corns are formed in the same manner but since they occur be tween the toes, usually between the fourth and fifth where there is greater perspiration the corn is macerated and softer than the hard corn They

are due to the pressure of the toes against each other, especially when a narrow, pointed shoe is worn Usually there is a spur on one of the phalanges, increasing the pressure They may prove resistant to treatment unless shoe and foot hygiene are completely corrected The skin should be kept dry and clean A pad may be used between the toes to separate them Raising of the anterior arch accomplishes the same purpose Resection of the exostosis and its overlying bursa may be necessary A shoe with a wide anterior compartment should be worn

CALLUSES Plantar corns and warts are produced by intermittent pressure and rubbing as a result of ill-fitting shoes, poor hygiene and gait Continuous pressure results in the formation of an ulcer in the patient, with poor sensation and circulation They are formed at such points of pressure as the inferior surface of the heel, the ball of the foot under the heads of the metatarsals, and the plantar surface of the great toe Shoes with pads redistributing the weight away from these areas will assist in correcting the callus Any abnormality of gait must be corrected If the callus is very hard and painful, it should be carefully removed by a physician or reduced in size by means of an emery board or pumice stone

CARE OF THE FEET

Concurrent with the demands of a changing civilization, the functional requirements of the foot have undergone alterat on The uneven, rough ground trod by primitive man in bare feet, has been changed to a smooth hard surface Present day occupations frequently enforce long periods of standing or conversely of sitting Covering for the foot is purchased too often with an eye for style rather than for usability Perhaps a greater advance in this respect has been made in the case of the male rather than the female Men look for comfort considerably more than do women Protection from heat, cold, and trauma is essential but at the same time the normal physiologic function of the foot must be satisfied

A normal amount of exercise is necessary for all parts of the body, and the feet are no exception Occupations necessitating prolonged standing with its resultant venous stasis, and strain on the muscular support of the foot should provide for frequent periods of rest Similarly, when one must sit for several hours at a time the foot should be exercised to maintain the normal muscle tonus

Stockings have a definite physiologic duty and not wearing them is harmful The prerequisites of good hosiery are that they be good absorbents of moisture nonconductors of heat, and provide adequate protection

from heat and cold Many synthetic products are used in the manufacture of hosiery, but silk and wool remain the only materials which most completely comply with the requirements Silk absorbs moisture readily, and does not conduct heat Wool is a better absorbent, and at the same time has a slight elasticity which affords some support for the vascular structure of the legs It also can be used when more warmth is desired Combinations of both may be used Cotton is a poor substitute Stockings should fit properly, providing enough room, yet not being so large that folds form creasing the skin and rubbing it to cause blisters and calluses If they are too short and narrow the foot will be constricted, stretch stockings may also do this and may be harmful to growing feet They should be changed frequently The foot is kept covered for longer periods than any other part of the body consequently the skin requires special care Feet should be bathed often and for this purpose there is no substitute for soap and water If the feet perspire freely, or the veins remain distended the bath should be finished with cold water After bathing the soap should be washed off thoroughly the skin dried, and a mild dusting powder applied lightly

The nails should be kept clean and cut straight across not curved in the manner of fingernails Any abrasions, corns calluses or blisters should be treated immediately as described

The rigorous training program in military service and the physical stamina required under battle conditions increase the importance of *foot hygiene* For this reason special precautions are taken Periodic inspection of the feet by a medical officer is necessary to enforce all the hygienic measures mentioned Trauma is prevented by correctly fitting shoes and socks and by gradually accommodating the feet to increasing weight bearing until a full pack can be carried for long distances without any discomfort At no time should a force be applied exceeding the amount which the feet can adequately carry After long marches the feet should be washed in cold water thoroughly dried and a dusting powder applied If the feet become tender they should be bathed in warm salt water alum water or a 1 per cent solution of formalin Swollen feet and profuse perspiration will be benefited by soaking them in a 2 per cent solution of formalin elevation and exposure to air Shoes should be air-dried opened to the sun and stretched preferably with shoe trees before being worn again preferably with a day intervening Socks should not be worn again until they are washed and dried Following exposure to cold and moisture a foot bath with soap and water cleansing thoroughly followed by a vigorous massage for at least twenty minutes, and changing to dry socks

and shoes are of extreme importance in the prevention of vascular disturbances, such as chilblains, emersion or trench foot, and frostbite

FITTING OF SHOES

Poorly designed shoes built on the assumption that all feet are alike, together with the public demand that the shoe be fashionable, are to a great extent responsible for many of the functional foot ailments There are certain requirements for a well fitting shoe

The *sole* should be of the straight last type that is the inner border should be a straight line from heel to toe The outer flare should have a wide curve to allow room for the lateral toes The sole should be thick enough to protect the foot from hard surfaces and to support the foot, yet it must be pliable enough to allow for normal flexion of the foot Leather serves these purposes best

The *shank* should be wide enough for support, yet it must allow the upper to fit snugly under the longitudinal arch and over the instep when the shoe is laced A rigid metal shank is not necessary if the sole is thick enough However, a lightweight metal will provide additional support, yet not impede the normal rolling motion of the average gait The shank should be slightly higher on the inner side for support of the longitudinal arch

The *anterior compartment* must allow ample room for movement of the toes The toe should be rounded Attention has been called previously to the ill effects produced by the pointed shoe A high *cap* is needed to avoid pressure on the toes especially the great toe

The *heel* should be wide enough for a stable support The average height for men is about one inch while it may be two inches or less for women Although high heels, as in dancing shoes are harmful if worn continuously there is no objection to using them intermittently In this way one may conform to style A rubber heel is more resilient than leather, and may afford slightly more protection The *counter* should fit snugly, and there must be no gaping at the top

A pliable leather, such as calf, is preferred for the *upper* Patent leather is poor because of its lack of porosity A low shoe will allow more freedom at the ankle and provides better ventilation High shoes protect the ankles and are necessary for rough terrains and when heavy weights are to be carried The *lining* of the shoe should be of duck smooth, and free of wrinkles This is preferable to leather, which may harden and crack

Fitting the shoe must always be done with full weight bearing, because the foot is then expanded to its largest size If there is about one half inch of space beyond the great toe, allowance for movement of the toes has been made The ball of the foot should lie over the widest part of the sole, which is at the first metatarsophalangeal joint There should be ample room across the anterior arch, but it cannot be so wide that the foot can shift in the shoe If a longitudinal arch support is to be added extra room is necessary to allow lacing comfortably over the instep

Fitting of the Army shoe requires special attention, and should be done with the soldier carrying a forty-pound pack and putting all his weight on the foot wearing the shoe The laces should be tightened The width of the thumb represents the correct distance between the end of the great toe and the end of the shoe The same care is taken to see that the shoe is neither too wide nor too narrow The shoes must be well softened by manipulation and repeated rubbing with saddle soap before they can be used for long marches Slippers and sneakers cannot be substituted for shoes They are to be used only for the purpose that they are intended to serve

SUMMARY

An attempt has been made to show how the anatomy and physiologic function of the foot can be altered by various factors, such as poor posture trauma, and ill-fitting shoes Only those conditions which are commonly met with in civilian and military life are discussed especially those which can be corrected by simple measures Too great stress cannot be placed on the necessity for proper exercise, the correct manner of walking personal hygiene, and the selection and fitting of shoes The individual with an essentially normal foot, who heeds these preventive measures will seldom have to be reminded that while ailments of the foot may be minor, pain is of major importance

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Medical Emergencies

MAX M MONTGOMERY

Medical emergencies during actual warfare or at the scene of a catastrophe are not so numerous as surgical emergencies However, civil populations subjected to alarms or frequent disruptions of normal routine are bound to present many emergencies of a medical nature This is true especially before any definite method of moving or sheltering the population has been thoroughly worked out Older people small children, and individuals in poor health must be given special attention Large groups of people confined to small, ill ventilated rooms lacking adequate temperature and humidity control present numerous problems The hurrying incident to any emergency throws an additional load on the cardiovascular systems of older persons Exposure to weather, the acute infections prevalent at certain times and many other abnormal conditions precipitate emergencies

Disregarding the abnormal circumstances mentioned above, there will always be a number of medical emergencies due to disease present at any given time in certain individual members of the population It is essential that many persons have some training in the recognition and treatment of the more common emergencies Those who urgently need expert medical attention should not be neglected because of erroneous concepts held by first aid workers Neither should hysterical or neurotic individuals disrupt the work of busy medical personnel It may be difficult to differentiate such conditions Needless to say the patient should receive the benefit of the doubt

Do no harm to the patient should be uppermost in the minds of those ministering to emergency patients Often it is difficult to stand by and do nothing In this chapter an attempt will be made to stress *what not to do* as well as *what to do* It always should be remembered that an unconscious patient like a baby is at the mercy of his environment Do not injure him by rough handling or forceful manipulation

The rationale of treatment of emergencies can be appreciated better

after the mechanism of their development has been discussed Such knowledge conditions one s thinking and does away in part with rule of thumb therapy

Calmness in the approach and manner of the responsible person lends assurance to the patient and those near him It is well to look for a notice or letter which may give a clue to the cause of the patient s illness For instance many diabetics carry a card identifying their disease and giving instructions for their care This is also true for some epileptic or cardiac patients and for some individuals taking cortisone or other adrenocortical steroids The purpose of this chapter is to explain the common phenomena seen in people taken suddenly ill and to suggest practical ways of aiding them while awaiting medical help

FAINTING OR SYNCOPE

Fainting or syncope is by far the most common medical emergency Few clinical conditions present a more dramatic picture It is an acute usually transient state in which there is a sudden complete or incomplete loss of consciousness with loss of normal muscular power The circulation may fail temporarily or the patient may stop breathing for a few seconds

Symptoms and Signs The onset of the episode varies The patient may be nauseated, belch, or even vomit Yawning giddiness, or a feeling of lightheadedness are often present The individual feels that he should lie down and often does so regardless of where he may be The general appearance preceding the faint is characteristic The face is deathly white and the exposed portions of the body especially the forehead, are covered with perspiration Just before collapse he may experience a sensation of coldness or numbness starting at the lips, fingers, or toes Things ' turn black before his eyes and he slumps to the ground He may be vaguely conscious of what goes on about him or lose consciousness completely At the other extreme is the patient who without any recognized warning collapses suddenly and falls to the ground where he lies motionless or has convulsive movements of the face extremities or body There is probably no other condition which so closely resembles death and conversely sudden death may simulate collapse or syncope

During the attack the pulse may be slow or rapid and thready Breathing may be shallow or rapid or cease temporarily The patient may empty the bladder or rectum The duration of the attack varies a few seconds to several minutes Consciousness returns gradually and the patient usually does not remember the period immediately prior to the attack

hence the comic page query, "Where am I? ' Gradually, recovery of muscular power and coordination return, and the patient begins to feel better However, he may remain pale, perspiring and weak for a time Headache and loss of appetite also may persist Always remember that the patient may injure himself when he falls Lacerations or fractures may be sustained if the collapse is sudden, or he may fall against a radiator and suffer second or third degree burns

Mechanism of Syncope, or Fainting The mechanism of syncope is fundamentally the same in all types, i e a cerebral (brain) anemia due to deficient circulation of blood through the brain Maintenance of an efficient circulation depends upon three main factors 1, the heart, which acts as the motive force circulating the blood, 2 an adequate volume or quantity of blood to fill the system and give the heart something to pump and 3, the vascular system consisting of arteries capillaries and veins which act as conduits for the blood Any one or any combination of these factors may be responsible depending on the type of syncope For instance, in syncope of heart disease the heart is the primary factor Syncope associated with hemorrhage or shock is due primarily to absolute loss of blood volume while decreased vascular tonus may be a secondary factor In still other cases the vascular system may be primarily at fault The vessels are of varying diameters and their walls are contractile The smaller vessels or capillaries of the body when completely expanded or filled will hold several times the amount of blood contained in the body The majority of these small capillaries at any one time are contracted with no blood circulating through them At intervals some dilate as others contract so that at one time only a relatively few contain flowing blood A widespread loss of this contracted state leads to the collection of a large amount of blood in some of the dilated vessels and an absence of blood in others The volume of blood then becomes too small to fill the vascular bed This results in a decrease in the quantity of blood returned to the heart and consequently a decrease in the cardiac output or blood pumped by the heart Thus there is insufficient circulation to the brain and fainting or syncope occurs

A common type of fainting is that having its origin in the higher centers of the brain This has been spoken of as *psychic shock* The mere thoughts of a horrible accident or thoughts of a gruesome sight may lead to an attack of syncope or fainting Likewise, sensory stimuli such as the sight of blood or the hearing of bad news may initiate fainting

This is due probably to an inhibition of the vasoconstrictor center of the brain by reflex stimuli from the cerebral cortex This center is re-

sponsible for maintaining the tonus of the vessels of the body Over activity of the carotid sinus (a small piece of tissue on the common carotid artery located at its bifurcation and containing terminations of specialized nerves) also causes inhibition of the vasoconstrictor center and stimulates the vagus center Thus there is a dilatation of the vessels with enlargement of the vascular bed and often a slowing of the heart with decreased cardiac output

The carotid sinus and the arch of the aorta are very sensitive to changes in intravascular pressure An increase in the pressure within these vessels leads to a reflex slowing of the heart with lowering of the blood pressure A decrease in the pressure leads to a speeding up of the heart and an increase in the blood pressure Thus, changes in position do not normally cause circulatory disturbances, since these reflexes automatically adjust the blood pressure and blood flow The failure of this mechanism to function normally or to compensate fully for a loss of circulating blood volume with resulting low pressure leads to insufficient circulation through the brain followed by fainting

Some individuals do not respond normally to a decrease of pressure in the carotid sinus This is especially likely to happen on sudden changes of position and is spoken of as *postural hypotension* (low blood pressure upon standing) If other phenomena such as flushing of the face and rapid changes in blood pressure are present, the syndrome often is called *neurocirculatory instability* On the other hand, some people have abnormally sensitive carotid sinus reflexes and any pressure on the neck which is transmitted to the sinus such as a tight collar, pressure with the hand or from a tumor or turning the head a certain way, is followed by a sudden slowing of the heart with lowering of the blood pressure and fainting

Inadequate return of blood to the heart is one of the causes for the decreased output of the heart leading to syncope Although the pressure in the veins is low there is a definite force transmitted through the capillary bed which forces the blood on toward the heart When a man is in the upright position, gravity assists the return of blood through the large veins of the head neck and upper chest to the heart However, the blood from the feet and regions below the level of the heart must rise against the force of gravity In this it is assisted by the tonus or state of contraction of the leg, thigh and abdominal muscles The larger veins contain valves so that the columns of blood are lifted as the leg and thigh muscles contract in walking If an individual stands still without moving about,

there is a tendency for pooling of the blood in the small vessels of the lower extremities The capillaries if not able to obtain fresh blood dilate still further because of a lack of oxygen Eventually, a considerable quantity of blood is immobilized in the feet and legs If the weather is warm and the skin and vessels are dilated, the process is further aggravated When the return flow of blood is insufficient for the maintenance of an adequate blood flow through the cerebral vessels the individual faints This type of syncope is seen in individuals who faint while watching a parade on a hot day or while riding in a hot, crowded street car It can be likened to the Roman crucifixion which is an example of syncope or collapse followed by death The victim was hung on the wooden cross so that his feet almost touched the ground Frequently, a small piece of wood was placed under the feet to prevent the victim from sliding down The extremities were either nailed or bound to the cross If nailed, the bleeding was no appreciable factor in the causation of death for it soon stopped Some strong men would live for some time while others died within one or two hours Renon believed that the real cause of death was the unnatural position of the body which brought on a circulatory disturbance with pain in the head heart, cramping of the limbs, and finally death The form of torture of hanging by the thumbs also led to death if the victim was not cut down after collapse occurred Certain animals held in an upright position collapse and die The above have the same mechanism as collapse or syncope and are caused by the insufficient return of blood to the heart due to pooling in the lower extremities This pooling is more marked in the above examples because when the weight of the body is not borne by the lower extremities the leg and thigh muscles are relaxed Thus the firm muscle support to the veins is lost and the larger vessels also dilate thereby producing serious stasis of blood

The fainting associated with heart disease is due to a decrease in cardiac (heart) output Changes in rhythm may be responsible for the alteration of output These changes include 1, periods of ventricular tachycardia (increase in rate of heart caused by an irritable focus in the ventricles) 2 periods of asystole (periods in which no heart beats occur) as seen in the change from a partial to a complete heart block and 3, sudden attacks of auricular fibrillation (irregular beat arising in the auricles) These disturbances may diminish the amount of blood leaving the heart and the pressure under which it is circulated causing a transient loss of consciousness

Massive hemorrhage from a peptic ulcer often causes fainting This

is due to acute blood loss with decreased blood volume The patient may vomit blood or have a number of black tarry bowel movements Many times the true cause is not at once apparent

In general, fainting or syncope seldom is seen in individuals who are seated or reclining It is apt to occur in people who stand in one place for long periods of time, especially if the environment is warm, for instance, in a crowded car or shelter It is more common also in older individuals who have been without adequate food or sleep or in those who are unduly excited or frightened Pain is a precipitating factor Suggestion may play a role One person may faint and then in rapid succession several others In older people the gradual rising from a chair or bed with a short wait for circulatory adjustment prevents syncope Even in younger people syncope is common on getting out of bed following a prolonged illness

Treatment The emergency treatment of this condition is simple but should be applied immediately Do not attempt to support the patient upright or move him in this position The body should be placed at once in a horizontal position with the head lowered or the feet and legs elevated Turn the head gently to one side and if the patient is vomiting turn him face down with the head turned to one side and resting on the back of one of his hands In this position he has an opportunity to breathe and does not aspirate or inhale the vomitus or swallow his tongue *Do not force fluid of any kind into his mouth* An unconscious patient inhales or aspirates these fluids into the trachea and bronchial tree and this may be followed by pneumonia Loosen the collar or clothing about the patient s neck The face may be rubbed with cold water but do not pour large quantities of water over the patient s face or head The patient should have access to fresh air and excessive crowding about the patient should be prevented Five per cent carbon dioxide in oxygen may be administered if available Inhalation of spirits of ammonia or other olfactory stimulants is helpful Adrenalin may be administered parenterally if trained personnel are present and the unconscious state is prolonged The most important thing to remember is that the essential treatment has been initiated when the victim falls to the ground The lowering of the level of the heart allows venous return which is followed by resumption of a normal cardiac output and improvement of the cerebral circulation An unconscious person is helpless His reflexes are depressed or absent He cannot swallow and his muscles are flaccid or relaxed *Handle him gently*

Often the attack can be prevented by having the patient sit down and lean forward so that his head approximates his knees Another position which is helpful if the patient is able to cooperate, is one in which he

kneels on one knee with his head far forward, as in tying a shoelace This position facilitates venous return to the heart

EMERGENCIES DUE TO HEAT

As the result of various oxidative processes within the normal body a predictable amount of heat is generated If this heat is liberated as it is formed, there is no change in the body temperature If it is liberated more rapidly, the body cools to a point at which the production of heat is accelerated and the excess is available to make up the deficit, thus maintaining the body temperature Interference with elimination of heat leads to its accumulation and to elevation of the body temperature The individual is then said to have a fever It is well known that the speed of chemical reactions is regulated by the temperature of the reacting substances With an elevation of body temperature and the temperature of reacting substances these reactions speed up and additional heat is produced Failure to eliminate sufficient heat leads to a vicious cycle Not only the normal but additional quantities of heat must be lost

In the usual environment the heat produced within the body is brought to the surface largely by the blood stream and escapes to the cooler surroundings by conduction and radiation Air movement or a breeze which strikes the body causes additional heat loss by convection When the temperature of the surrounding air becomes equal to or rises above that of the body, then all the heat must be lost by vaporization of the moisture or sweat from the skin surfaces As the air becomes more humid, that is, contains more moisture the vaporization from the skin surface slows down A day on which the temperature ranges around 95° to 100° F with high humidity and little or no breeze furnishes ideal conditions for the retention of heat It is on such a day or, more commonly, succession of such days (heat waves) that medical emergencies attributable to heat occur

Old people and individuals with heart disease have circulatory systems that adjust poorly to such conditions and they suffer excessively from the heat Children with unstable vasomotor systems also are quite sensitive to heat Patients with hyperthyroidism who are producing excessive quantities of heat because of an increased metabolic rate and who have embarrassed circulations and damaged livers, may develop hyperthyroid crises during heat waves Emergencies due to heat usually are classified under three clinical states

Heat Exhaustion This syndrome occurs in individuals working in hot

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The *treatment* of heat cramps is salt, either in tablet form or as salted drinking water Manual pressure on the cramped muscles gives some immediate relief

Heatstroke (Sunstroke) This condition is especially common in alcoholics or elderly individuals exposed to hot environments for prolonged periods It is associated almost always with a cessation of sweating This results in a storage of heat so the patient's rectal temperature is high The skin is dry, red, and hot in contrast to the pale, moist skin seen in heat exhaustion The pulse is rapid The patient may be unconscious and remain so for some time Apparently there is a fatigue of the sweating mechanism This condition is very serious and in contrast to heat exhaustion, the mortality is high The history of exposure to excessive heat, headache with loss of consciousness with or without convulsions should suggest the possibility of heatstroke If the skin is hot, dry, and red and there is a high rectal temperature and no paralysis, treatment should be started immediately Rectal temperature often registers as high as 110° to 112° In confirmation of this, during the late war there were reports from desert training centers of individuals who apparently had a primary disturbance of the sweating mechanism which led to hyperthermia Recovery was slow, often taking several weeks

TREATMENT Remove the patient to a cool place if possible Elevate the head slightly and apply cold applications to the head neck and extremities either by cold packs or by a spray, or better still wrap the patient in a constantly moistened cold wet sheet Gentle rubbing of the skin through the sheet helps maintain the skin circulation After a few minutes the cold applications can be stopped If the skin again becomes hot, renew the treatment Often other modes of treatment, such as ice packs, must be resorted to The patient should be placed under competent medical supervision as soon as possible The medical treatment is that of a patient who is in shock and who at the same time has a high fever He should be supplied with cool solutions of plasma and salt by vein and oxygen by inhalation

EMERGENCIES ENSUING FROM HEART DISEASE

There are several types of heart disease but only those likely to cause emergencies will be considered The treatment is primarily a problem for the physician and medical aid should be obtained as soon as possible This is true especially in those cases in which collapse, chest pain or shortness of breath are the main complaints Palpitation rapid heart beat

environments and may be associated with heat cramps This is a form of syncope brought about by the pooling of blood in the vessels of the skin The heat is transported from the interior of the body to the surface by the blood The skin vessels become dilated and a large amount of blood is pooled in the skin This together with the blood pooled in the lower extremities, when in the upright position, may result in an inadequate return to the heart and collapse of the individual The pulse is weak and breathing usually is shallow Loss of consciousness is transient After the patient collapses, the skin changes from red to the very white appearance typical of syncope or fainting The body surface feels cold and clammy The skin vessels usually constrict and this combination of decreased heart output plus constriction of the skin vessels accounts for the pallor The rectal temperature if taken will be found to be normal or slightly elevated even though the skin may feel cold The person looks like an individual who has fainted and responds to the same treatment However, some of these people do not recover rapidly because vasomotor control of the capillaries is not normal It often takes a day or so for vascular control to return, and during this period the patient should be protected from heat This condition is often of such severity that it approaches very closely the shock state The difference is really quantitative

Treatment for heat exhaustion consists of lowering the head and moving the patient to a cooler environment Cool applications to the forehead and skin are of value Much of the clothing may be removed since exposure of the skin facilitates the loss of heat Fanning also results in heat loss by convection The patient recovers consciousness quickly, although he may not feel well for some time Salt tablets or intravenous salt solution should be administered If the condition is very severe, elevation of the feet legs, and hips above the level of the upper half of the body is advisable Often the application of light bandages to the extremities, so-called "auto transfusion" with compression of the more superficial veins, is of great value

Heat Cramps Heat cramps are seen in people who work in hot environments and perspire a great deal It is the loss of salt from the body which causes these very painful cramps of the leg muscles and abdominal muscles This condition may be associated with heat exhaustion Heat cramps at one time were very common in foundry workers and steelmill workers However, in recent years the men have been supplied with salt tablets or capsules or salted drinking water and the condition is not common The salting of beer, which for many years was a common practice, helped replace the salt loss through excessive perspiration

inhalation may be the most valuable help in the world Do not attempt to force a patient to hurry or run during a seizure no matter how urgent the situation It may be a lifesaving measure to allow him to lie down or sit in the street One may need to direct traffic around the patient until the attack has ended After subsidence of the pain, help the patient to a place where he may rest If the pain does not subside completely or if it is the patient s first experience, see that a physician is called at once

Acute Left Heart Failure This condition usually is seen in patients who have had high blood pressure or in older individuals with arteriosclerotic heart disease The main symptoms are severe dyspnea, or shortness of breath, and cough This may come on after exertion or at the end of the day Often the shortness of breath wakens the patient from a sound sleep, and is accompanied by a paroxysmal cough If acute pulmonary edema develops, the patient may cough up a large amount of watery, frothy blood tinged material These attacks often are confused with those of bronchial asthma As a result of failure of the left side of the heart there is a gradual accumulation of blood in the pulmonary circulation This reduces the available tissue for respiration, and this reduction in vital capacity is one of the main findings Increased pressure within the small capillaries leads to the exudation of fluid into alveoli thus producing the pulmonary edema manifested by the profuse frothy sputum

TREATMENT The treatment of this condition when well established consists of the administration of morphine In the milder attacks, the change to the sitting posture with an increase in activity and cough often will lead to an increase in the output of the left ventricle with gradual alleviation of the distress Recently the administration of oxygen, especially under positive pressure has been used with very good success when pulmonary edema develops In general, help the patient to the position of greatest comfort, usually sitting up and leaning forward Administer a narcotic preferably morphine codeine Pantopon, or Dilaudid, or send for someone who can administer the drug *Do not attempt to make these patients lie down* Fresh air and a cool environment are welcomed by the patient Medical aid should be called as these episodes may prove fatal

Acute Myocardial Infarction From the practical standpoint this is death of a mass of heart muscle due to closure by a blood clot or *thrombosis of a coronary artery* It was at one time called acute indigestion The pain is similar to that of angina pectoris except that it is more prolonged Collapse shock and sometimes loss of consciousness accompany the severe chest pain or upper abdominal pain which may persist for hours At the onset vomiting is often present The face is pale and per-

or irregular heart beat are symptoms which are annoying to the patient but usually are not serious

Angina Pectoris This term means "pain in the chest It is so widely used and understood that its continued use is justifiable even though the term is descriptive of a symptom This chest pain with the feeling of impending death is not a disease itself but is a manifestation of insufficient blood supply to some portion of the heart muscle At one time it was thought to be due to a spasm of one of the vessels supplying the heart muscle This is not the only factor Narrowing of a coronary vessel due to disease may reduce the blood flow If there is a demand for increased blood flow due to exercise or excitement, this narrowed vessel may be unable to supply the necessary amount This inadequate blood supply results in an ischemia or local anemia of the heart muscle, and pain is the result The attacks of pain characteristically occur after exercise or excitement and vary in duration from a few seconds to several minutes The pain usually is described as crushing or squeezing in nature, is located in the chest or upper abdomen and sometimes spreads up into the neck or down the left arm It may be very severe or just a dull ache The sufferer stops whatever he is doing stands perfectly still and may press his hand to his chest His face is ashen gray or pale and may be covered with sweat during the severe attack He breathes shallowly and is afraid to move lest he increase the severity of the pain The pain gradually subsides and the patient relaxes If the attack is severe he may state voluntarily that he was certain he was about to die Death may occur during the first attack or any subsequent attack although some individuals suffer from this affliction for years It is much commoner in men than in women and is infrequently seen in young adults The occurrence of sudden death is well known in those suffering from this complaint If the pain persists over a few minutes myocardial infarction (as described later in this chapter) due to a coronary thrombosis must be suspected

TREATMENT Prevention of attacks by refusal to hurry or to work or exercise unduly no matter what the emergency is the best treatment and sooner or later the patient learns this Nitroglycerin $1/100$ grain in the form of a small tablet or amyl nitrite in a glass pearl (perle) or ampule is carried by most individuals afflicted by this condition If the pain is very intense they may be unable to reach the medication and in such situations understanding assistance may be of great value An individual during an attack might only be able to indicate where he carries his medicine Placing a tablet of nitroglycerin under the tongue of the sufferer or breaking a glass pearl (perle) of amyl nitrite and holding it close to his nose for

TREATMENT The patient with auricular fibrillation should be assured that he is not going to die He should be allowed to sit up or assume the most comfortable position *It is safe to move him to a hospital* or to a place where medical treatment can be secured If the patient is coughing up blood or foamy sputum, morphine should be administered Having the patient breathe oxygen in high concentration is of value The patient should be seen by a physician as soon as possible After the pulmonary edema or hemoptysis subsides, the patient may be moved to a hospital

Paroxysmal Tachycardia This condition consists of attacks of very rapid heart beats with a feeling of faintness or weakness, and occurs quite frequently in some individuals who are nervous or easily upset They usually are very apprehensive and alarmed The heart, between attacks is apparently normal and transition from normal to rapid beating is sudden As a rule, a careful history will reveal the fact that the patient has had previous attacks of similar character

TREATMENT These attacks can often be stopped by drinking water, pressing with the fingers on one side of the neck, closing the glottis, and straining or pressing on the eyeballs The patient should lie down or assume the most comfortable position He should be assured that the attack is not dangerous and that he will not die He can be taken to a physician or a hospital for further treatment Many times sedatives, such as phenobarbital 0 1 gram or sodium bromide 1 0 gram, will terminate the episode after a time The subcutaneous injection of Mecholyl or acetyl betamethyl choline chloride or the oral administration of quinidine and digitalis may be needed but these drugs should be prescribed by the physician rather than the individual administering first aid This condition occasionally persists for days and then is dangerous in that the heart may gradually decompensate or fail from fatigue

In review attacks of chest pain, attacks of shortness of breath and cough, collapse or syncope, or attacks of rapid and irregular heart beat with a feeling of faintness or weakness are the presenting pictures in the various heart conditions In general allow the patient to assume the position which is most comfortable for him If he is unconscious, one may follow the rule of elevating the head slightly if the face appears red or congested and lowering the head if the face is pale or white *All heart patients do not need their heads elevated In syncope elevation of the head is dangerous* Assurance and calm behavior of those administering to the patient are important Get medical aid to the patient as soon as possible, or see that he is transported to the hospital in an ambulance

Hyperventilation Tetany Some individuals who present symptoms of

spiration stands out on the forehead The pulse may be slow, normal or rapid in rate The blood pressure sometimes is elevated, but if the picture is that of shock or collapse, the blood pressure is low The condition is differentiated from typical angina pectoris by the persistence of the pain If the patient loses consciousness, one differentiates it from ordinary syncope by its longer duration and the pain in the chest or abdomen complained of after recovery of the sensorium Acute myocardial infarction is very serious and is followed by sudden death frequently

Treatment consists of keeping the patient quiet and warm Avoid unnecessary moving or examination A patient with severe chest pain should be given nitroglycerin 0 6 mg on the tongue or should inhale the contents of an amyl nitrite ampule If the pain is not relieved, send for a physician immediately Do not attempt to take the patient to the physician except by ambulance Oxygen in high concentration should be administered continuously if it is available If a physician cannot be brought to the patient within a short time, morphine sulfate 15 mg or Demerol (meperidine hydrochloride) 100 mg should be given hypodermically Atropine sulfate 0 4 to 0 8 mg has also been recommended If a physician is available within a very short time withhold narcotics until he has seen the patient There is always the danger of confusing this condition with some surgical emergency such as perforated peptic ulcer The administration of a narcotic may lead to confusion in diagnosis If the condition is typical and medical aid cannot be obtained for some time morphine or Demerol should be used

Stokes-Adams Syndrome This is a condition in which the patient loses consciousness for a short time and occurs usually in elderly individuals It is due to heart block a condition manifested by very slow pulse rate less than 40 per minute As soon as the body adjusts to the slower heart rate the patient improves *This patient may be taken to the doctor or to a hospital* He should be kept flat and oxygen administered if it is available

Rheumatic Heart Disease A patient with rheumatic heart disease may manifest symptoms suddenly due to the onset of an auricular fibrillation The patient complains of fluttering or irregularity of the heart The pulse become rapid and very irregular Such irregularity in young persons almost always is due to fibrillation Another complication of rheumatic heart disease is hemoptysis or the coughing of blood This occurs in patients with rheumatic heart disease of long standing in which the mitral valve opening is contracted to the size of a small buttonhole The blood accumulates in the lung back of the obstruction

for a variable time after the attack, although following mild seizures, some patients awaken immediately It may be difficult to judge the nature of attacks of this type but if the tongue is injured or the patient involuntarily empties the bladder or rectum, it is usually epilepsy

Treatment of epilepsy consists essentially in protecting the patient A gag between the teeth to protect the tongue may be used This should be of wood, such as a pencil covered with a handkerchief Insert it with care Do not break the patient s teeth Place a pillow or coat under the head to protect the face or head from injury Do not attempt to hold the patient still but move surrounding objects so he will not injure his extremities *Do not attempt to pour liquids into his mouth* If the seizure lasts for some time or the patient passes from one convulsion to another, *summon medical aid* As previously mentioned, anesthesia or heavy sedation occasionally is needed to control the convulsions

Convulsions in Children General convulsions in infants and young children have various causes In infants convulsions usually are due to birth injuries, or tetany on the basis of vitamin deficiency In older infants and young children they may mark the onset of acute infectious diseases, gastrointestinal upsets or possibly epilepsy They often represent the child s reactions to a sharp elevation in temperature

The *treatment* consists of keeping the child quiet until medical aid arrives This is best accomplished by immersion in a tepid tub of water Be sure the water is not too hot as many fatal burns have resulted from such treatment Test the water with the elbow or upper arm, not with your hand Do not pour water into the tub without first removing the infant In older children if the skin is hot as in the onset of an acute infection lukewarm or tepid sponging of the body may reduce the temperature and stop or prevent recurrent convulsions If the child is not a known epileptic every effort must be made to obtain medical aid

Eclampsia This condition manifests itself in the later months of pregnancy during labor or soon after delivery of the child by convulsive seizures This is a very serious condition and is an acute emergency

TREATMENT Call a physician immediately Keep the patient absolutely quiet and make no attempt at examination between seizures Darken the surroundings if possible During the convulsion protect the patient by placing a gag between the teeth Move surrounding objects and place some protective material such as a blanket or coat beneath the head and body

Hysteria Hysterical attacks usually occur in young women Unconsciousness is not present but the patient may be in a trancelike state This

nervousness, tremor, insomnia, and anxiety are subject to episodes which simulate, on the one hand heart attacks, and on the other hysterical at tacks Following a period of unnoticed, rapid deep breathing, they be come panicky, complain of difficulty in getting their breath, tingling and numbness of the hands and feet If they persist in breathing rapidly, the heart rate increases and they may even lose consciousness The hands often assume a characteristic position with the fingers extended and with ulnar deviation of the hands at the wrists

TREATMENT This consists of regulating the patient s rate and depth of respiration by instructing him to hold his breath or to breathe slowly Rebreathing into a common paper bag held tightly over the nose and mouth is an effective method of terminating an attack

CONVULSIONS

Convulsions are paroxysms of involuntary muscular contractions They may be localized to one part of the body or be generalized and involve both sides of the body face, arms, trunk, and legs In the typical convulsion, the patient is unconscious If the onset is sudden, he may fall and injure himself If the muscles of the face and jaws are involved, the mouth foams and if the tongue or cheek is bitten the foam becomes bloody The breathing is loud and labored due to the clenched jaws Con traction of the neck muscles interferes with venous return and the face becomes congested and cyanotic or bluish in color The movements of the muscles are jerking in character purposeless, and the amplitude of movement is dependent on the rigidity of the muscles

Epilepsy This disease is probably the most common condition in which convulsive seizures are seen These attacks may be preceded by a sensory aura a peculiar smell sound or visual sensation which warns the patient of an impending attack In such cases he may be able to lie down in anticipation of the onset Patients who have no forewarning may fall or throw themselves on the floor or ground with a hoarse cry The muscles usually are tense for 5 to 30 seconds during which time breathing stops Then the legs arms head and body jerk spasmodically The face usually is pale just prior to the attack but blue or cyanotic at the height of the seizure The tongue often is bitten and frothing at the mouth is common The patient may involuntarily empty the bladder and rectum Usually the seizure subsides in a few minutes although there is a type, *status epilepticus* in which the patient passes from one seizure to another until anesthetized or until given deep sedation The patient usually sleeps

injury and often are associated There may be a cut on the head or a bump at the site of injury Inequality of the pupils indicates brain damage Bleeding or discharge of a clear fluid from the ears almost certainly means skull fracture The pulse rate and blood pressure depend on the amount of brain damage and whether or not the patient is in shock Paralysis or weakness of the muscles of one side of the face or of one or more extremities indicates severe brain damage This condition is dealt with in detail elsewhere

Uremic Coma This is seen in advanced kidney disease The onset of uremic coma is gradual and such a patient usually is found at home in this state He does not develop it on the street Neighbors and friends usually will tell you that he recently has been unable to see well, has had headaches, or been mentally confused or drowsy The breathing is of the acidotic type, that is, forced, deep, and rapid The pulse is full and hard There is an extremely unpleasant odor to the breath, the so-called uremic odor There may be small white crystals of uremic frost on the patient s nose or forehead The tongue is dry and the skin is not only dry but often cold The blood pressure usually is high

TREATMENT There is no adequate first aid treatment Keep the patient warm and summon medical aid

Diabetic Coma This is due to an acidosis arising from uncontrolled diabetes mellitus The patient often has a card or notice on his person stating that he is a diabetic or he may have a friend or relative who volunteers this information At the onset, the patient can be aroused but usually is confused and unable to cooperate The characteristic breathing of acidosis is present This is deep forced pauseless rapid respiration in which the abdominal and accessory muscles may share These respirations resemble those of a sprinter at the end of a run There is no evidence of obstruction of the air passages The skin is dry and not cyanotic Dilated venules filled with blood may be seen on the extremities giving rise to the picture described as *cutis marmorata* The odor of the breath is that of acetone This has been described as a sweetish or fruity odor The breath in uremia has an entirely different odor In diabetic coma the amount of sugar in the blood is increased markedly

TREATMENT These patients should be moved to a hospital immediately They require careful expert attention including urine tests blood tests and insulin therapy There is no adequate first aid treatment

Hypoglycemic Coma This is due to an overdose of insulin to a failure to obtain food after taking insulin or more rarely to pancreatic tumors The term hypoglycemia means a decreased amount of sugar in the blood

can be distinguished from coma by the fact that the body is held rigid The eyes are closed tightly and there is a definite resistance when an attempt is made to raise the upper lid Convulsive seizures also may be seen These are atypical and not characteristic of true convulsions The voice may be lost The patient may complain of blindness or of being able to see only two small fields directly in front of the eyes, so called tube vision There may be a lump in the throat which the patient is unable to swallow Anesthesia or loss of sensation of the hands and forearms, feet and legs, so called glove and stocking anesthesia, is common Laughing and crying fits do not present much difficulty in diagnosis However, the diagnosis of hysteria is dangerous and unjustifiable unless all other conditions have been excluded and should be made only by an experienced physician

TREATMENT If the patient is known to have attacks, the best emergency treatment is a word to the patient as to their known nature and then strict neglect If no attention or alarm is manifested, the attack tends to subside Oftentimes the mere suggestion of some treatment such as dilatation of the anal canal will be followed by improvement If this improvement is very prompt, the patient probably is malingering

Local Convulsions Local convulsions or convulsive movements involving a group of muscles or muscles of one extremity usually are due to habit spasm tic, hysteria, malingering, or a brain lesion due to depressed bone or a tumor

TREATMENT There is no practical first aid treatment for such local convulsions They are not serious Sedation with 30 mg phenobarbital may control them to some extent Send the patient to a physician

COMA

Coma is a state of unconsciousness The diagnosis of the cause of coma often is difficult even when one has diagnostic facilities available However a few conditions cause the majority of cases and these will be taken up briefly with emphasis on the characteristics which enable one to recognize them An unconscious patient must be looked over carefully for signs of injury He may have a *skull fracture* An alcoholic odor to the breath may or may not mean that the patient is intoxicated One should look closely at the face to see if one side is flattened or pulled over The size of the two pupils should be compared One should examine both arms and legs and compare the rigidity or tenseness of the muscles of the two sides

Skull Fracture or Concussion These conditions usually follow an

stimulants by hypodermic injection The physician will decide as to whether he wishes to use hypertonic intravenous solutions Such treatment is not to be classified as first aid If the hemorrhage is massive the patient may die within a short time

Coronary Thrombosis This has been discussed under heart disease If a large segment of the coronary artery is involved, an infarction of the myocardium will develop If there is massive infarction of the myocardium with profound collapse and shock, the patient may lose consciousness and be seen in coma If there is a history of severe chest pain prior to the loss of consciousness, coronary thrombosis may be suspected The blood pressure usually is very low and the patient may have a rapid pulse Breathing may be intermittent or shallow and rapid The treatment has been discussed

Alcoholic Intoxication Excessive indulgence in alcohol is one of the commoner causes of coma One should look over the patient very carefully for injury before deciding that his condition is solely due to alcohol The odor of alcohol is not proof that the patient is intoxicated The patient may be semiconscious Early the face is flushed, the pulse is slow and bounding and the breathing is even and fairly deep More recently, determination of the alcoholic content of the blood has been used as a diagnostic procedure If feasible, such a patient should be taken to a hospital for medical attention

TREATMENT Washing the stomach removes unabsorbed alcohol and may be valuable in establishing the diagnosis Intravenous glucose and oxygen often revive patients more rapidly than other measures Stimulants administered subcutaneously, such as caffeine sodium benzoate, often will bring the patient around in a short time If the pulse becomes weak or the patient collapses oxygen and artificial respiration should be used Summon medical aid since the alcoholism may be incidental to some other condition

CHEMICAL AND DRUG POISONING

Poisoning by ingestion of various substances, either by accident or with suicidal intent is frequent Accidental poisoning invariably is due to carelessness Children are attracted by colored capsules, tablets, or liquids and will swallow them if they are left within reach One should always read the label on any bottle before taking or administering its contents *Do not use the contents of an unlabeled bottle* If there is *any* question about the dosage of medicine, inquire before using it Poisonous

An emergency might arise in time of war or catastrophe which would prevent the diabetic patient from obtaining his food after taking his insulin If a patient is found comatose and has a diabetic card in his pocket or is a known diabetic, hypoglycemic coma must be considered The respirations of coma due to acidosis have been described, those due to hypoglycemia in contrast are slow and shallow The patient is pale The tongue is moist, the skin often cool, but not infrequently moist and bathed in sweat

TREATMENT This is one condition under which the rule of withholding liquids from stuporous patients may be broken If the patient has sugar in his pocket he still may be sufficiently cooperative to swallow this or some other food If not, no time should be lost in securing a physician who should at once inject glucose (a form of sugar) intravenously Time is valuable, prompt action may be life saving Such patients should not be allowed to exert themselves since any exertion or work aggravates the hypoglycemia and deepens the coma The subcutaneous injection of adrenalin (1 ml of 1 to 10 000 solution) may terminate the reaction or coma These cases should be moved to a hospital or be seen by a physician immediately

Cerebrovascular Accident This is often called apoplexy or a stroke of paralysis Cerebral hemorrhage generally occurs in elderly patients who have had high blood pressure for some time Arteriosclerosis with a low blood pressure often leads to a cerebral thrombosis in which the onset is gradual In the common stroke due to *cerebral hemorrhage* the onset is sudden The patient falls off a chair or falls to the ground For a time he may maintain consciousness but there usually is a paralysis of an upper extremity lower extremity or both and of the face Consciousness may be lost within a short time The breathing is slow and deep the face is congested, and the pulse is strong and slow One side of the body is limp, and the arm or leg falls flaccidly when dropped The face may be flattened or pulled over to one side One pupil may be larger than the other or the eyes or head may turn to one side In typical *cerebral thrombosis* the onset is slow with a feeling of numbness in one extremity mental confusion and inability to concentrate Later the patient lapses into unconsciousness with or without paralysis This is due to a clot in a vessel The symptoms of cerebral hemorrhage and cerebral thrombosis are very similar

Treatment of this condition is one of inaction Elevate the head slightly place cold cloths or an ice bag to the head, do not move the patient any more than is absolutely necessary until medical aid arrives do not attempt to give the patient anything by mouth and do not give

The so-called universal antidote consisting of two parts of activated charcoal, one part of tannic acid, and one part of magnesium oxide is widely advocated The charcoal will absorb phenol and strychnine The tannic acid precipitates alkaloids, certain glucosides, and many metals The magnesium oxide neutralizes acids After each dose of one teaspoonful in water, vomiting should be induced There are proprietary preparations very similar to this universal antidote

If symptoms of shock develop, keep the patient warm and use artificial respiration if necessary Continue for several hours, even though the patient may be apparently dead The use of a respirator is especially valuable Oxygen or 5 per cent carbon dioxide in oxygen should be administered even though a respirator is being used Needless to say, it is imperative that an open airway be maintained

Phenol or Carbolic Acid Cresol, lysol, creosote, and guaiacol poisoning are treated the same as phenol poisoning If seen early and a stomach tube is available olive oil should be given by mouth The stomach should then be washed out several times with more olive oil Because of the local effect of the phenols, a tube should not be passed if the quantity taken was large or if the patient is seen late and is having severe epigastric pain Sodium sulfate or magnesium sulfate (Epsom salts) in concentrated solution 1 or 2 tablespoonfuls in a cup of water may be given by mouth Vomiting should be induced Then a demulcent drink such as milk, egg white in water barley water or flour in water should be administered Alcohol may be used to remove phenol from local burns However it should not be administered internally for treatment of phenol poisoning If the patient is in a state of collapse, follow the treatment for shock outlined above

Iodine The mouth and lips are usually burned and stained in iodine poisoning Vomiting and pain are the usual symptoms Later there may be thirst and a suppression of urine A solution of starch in water should be taken by mouth Induce vomiting or wash out the stomach Repeat this process several times Morphine may be needed to relieve pain

Barbiturates These include barbital or Veronal Luminal or phenobarbital Sodium Amytal Sodium Ortal Allonal Seconal, Nembutal, and others The symptoms of poisoning are headache mental confusion, staggering gait incoordination, drowsiness, and finally coma Occasionally nausea vomiting excitement, and hallucinations are seen If a very large dose is taken, deep coma with cyanosis and circulatory collapse appear quickly The deep reflexes and pupillary reflexes remain for a relatively long time Pneumonia due to shallow breathing and aspiration of secre-

drugs should be kept separate from other drugs or medications This applies to lay people as well as to druggists, doctors, dentists or first aid workers Do not put any caustic or poisonous substance in a used bottle without destroying the old label and applying a new one The practice of putting such substances as muriatic acid or turpentine in an old whiskey bottle has been responsible for many severe burns and poisonings Individuals under the influence of sedatives such as the barbiturates may without realizing it take an additional excessive dose They may then be under suspicion as potential suicide victims

The more common drugs taken with suicidal intent or by accident are phenol or carbolic acid tincture of iodine, lysol or some other cresol antiseptic, barbiturates, and mercuric chloride The barbiturates include barbital Veronal, Luminal or phenobarbital, Sodium Amytal Sodium Ortal, Allonal and Seconal Corrosive acids caustic alkalies phosphorus, arsenic, chloroform methyl alcohol, strychnine belladonna, atropine morphine, and codeine are some of the other drugs and chemicals which may cause poisoning *Vomitus or stomach contents should be saved for later examination when poisoning is suspected* A large number of proprietary preparations used in the home and in industry as cleaners solvents or other reagents are poisonous when ingested A list of the ingredients may appear on the label of the preparation or one may be able to obtain such information by telephone from a Poison Control Center Advice as to first aid may also be printed on the label

Chemicals and Drugs The symptoms and signs of chemical and drug poisoning depend upon the substance taken Strong corrosive acids (hydrochloric sulfuric and nitric acids) or caustic alkalies (lye and caustic potash) cause very painful discolored burns of the lips, tongue, and mouth as well as abdominal pain and severe systemic symptoms, if swallowed Barbiturates or alkaloids on the other hand cause no local action but have profound systemic action after absorption causing drowsiness and coma

Unknown Poison If the ingested poison is unknown the object of the treatment is to dilute the substance and remove it from the stomach Large quantities of fluid such as water milk or tea are given, and these are removed by use of the stomach tube or by induced vomiting If a stomach tube is not available, stimulating the back of the throat may induce vomiting If this fails, give an emetic such as a tablespoonful of mustard in a cup of warm water Apomorphine 6 mg by hypodermic injection or one tablespoonful of syrup of ipecac in a cup of warm water are often used It is next advisable to give the whites of several raw eggs or milk or both

aethyltetraphosphate), Malathion, OMPA (octamethylpyrophosphoramide), Parathion, and TEPP (Tetraethylpyrophosphate) These are too dangerous for use about the home but are employed in farming They interfere with normal nerve impulse conduction Nausea, vomiting, abdominal cramps, diarrhea, sweating constriction of pupils, productive cough, difficulty in breathing, anxiety, restlessness, mental confusion, difficulty in speaking, twitching of the muscles of the face and neck, and generalized muscular weakness follow exposure to excessive amounts of these sprays or dusts In severe poisoning, convulsions and coma occur and death may result from respiratory or circulatory failure

TREATMENT Intramuscular injection of 2 mg of atropine sulfate hourly until the full effects of atropine are obtained may be lifesaving Maintenance of an airway is important, and use of oxygen inhalation and artificial respiration may be necessary If the substance is taken by mouth, the stomach should be emptied and activated charcoal or universal antidote should be administered

Corrosive Acids The most common acids in this group include hydrochloric, sulfuric and nitric These cause painful discolored burns of the tongue and mouth, or marked swelling and edema of the tissues Abdominal pain and collapse follow if they are swallowed in any quantity Give no emetics and do not risk using a stomach tube

Alkalies are given in an attempt to neutralize the acids, milk of magnesia milk with borax, chalk or calcium carbonate, or lime water are used Soda bicarbonate and soapsuds may be given Later, milk, olive oil and frequent feedings of bland foods are given to neutralize the gastric acidity The patient should be kept warm Morphine is usually needed for pain Stimulants may be necessary If there is intense edema of the mucous membranes of the pharynx get the patient to the nearest hospital so intubation or tracheotomy may be performed if necessary

Caustic Alkalies Lye or caustic potash are occasionally swallowed accidentally The mouth and pharynx are damaged by the corrosive action of these substances Bloody vomitus is present if much is swallowed Avoid using the stomach tube These substances must be neutralized with a large amount of weak acid such as diluted vinegar, lemon juice, or grapefruit juice Milk or egg white should also be given Morphine is usually needed for pain Stimulants such as caffeine or strychnine may be necessary Keep the patient warm and in the recumbent position Get him to a hospital as soon as possible

Phosphorus Phosphorus is found in many rat pastes and also in matches The best treatment is to wash the stomach with a pint of 0 5

tions is the common cause of death Respiratory paralysis due to medullary depression is seen in severe poisoning

The treatment in the early stages consists of prompt evacuation and washing of the stomach Vomiting may be induced but a stomach tube is usually needed since the patient is drowsy or comatose An ounce or two of Epsom salts in four ounces of water should be left in the stomach to act as a purge If the patient is comatose, ephedrine sulfate 50 mg should be given by hypodermic injection every few hours In the severe case, picrotoxin in 10 mg doses should be given intramuscularly or intravenously every 30 to 60 minutes until signs of stimulation appear or corneal sensitivity returns An overdose of picrotoxin will cause convulsions Respiratory depression may be relieved by inhalation of 5 per cent carbon dioxide in oxygen Artificial respiration may be necessary The patient in coma should be moved to a hospital as soon as possible Intravenous fluids and other specialized treatment may be essential

Bichloride of Mercury The symptoms appearing within a short time consist of vomiting abdominal pain, diarrhea (often bloody), and collapse Somewhat later the mouth and throat show swelling bleeding and ulceration Death is usually due to kidney damage Occasionally complete suppression of urine for several days is followed by recovery

Haste is all important in the treatment of this condition Give the whites of 2 eggs and a pint of milk Induce vomiting or empty the stomach with a tube Leave an ounce of Epsom salts in solution in the stomach If eggs or milk are not available give soap and water Finally ground or chopped meat may be given in water Later induce vomiting Treatment of the later stages is a medical problem Intravenous salt solution sodium thiosulfate solution colonic irrigations and many other forms of therapy are used *The patient should be taken to a hospital or a physician immediately since early treatment with BAL (British anti lewisite) is imperative*

Arsenic Paris green and Rough on Rats are the common sources of arsenic in poisoning The chief symptoms are intense pain in the upper abdomen, vomiting diarrhea and collapse Treatment consists of rapid removal of the substance from the stomach by vomiting or by stomach tube Egg whites and milk should be given Magnesium oxide (2 teaspoonfuls) and tincture of iron (1 tablespoonful) to a cup of water should be given This converts the arsenic trioxide into an insoluble arsenate After the above treatment (which requires very little time) the patient should be hospitalized at once for BAL treatment

Organic Phosphate Type of Insecticides These include HEPT (hex-

crown of the head and the heels touch the floor or bed The legs are extended, the feet turned in, the arms flexed on the chest or extended, the fists clenched, and the jaw and face muscles strongly contracted producing a grimace known as risus sardonicus Such seizures usually last about a minute during which the patient stops breathing becomes cyanotic or blue, and may lose consciousness Further seizures follow immediately or somewhat later Consciousness is maintained between the attacks The victim is apprehensive and suffers severe pain during the muscular contractions Death may occur during the first convulsion and if untreated, the patient usually survives only two to five seizures

TREATMENT In case it is known or strongly suspected that strychnine has been taken and no convulsion has appeared, give strong tea or a solution of one teaspoonful of tannic acid in one-half glass of water Induce vomiting and make every effort to get a physician If convulsions are present give at once ether by inhalation until anesthesia is produced Slow intravenous injection of 10 per cent Sodium Amytal (0 4 to 1 0 gram) or pentobarbital sodium (0 3 to 0 7 gram) is the treatment of choice The dose should be given slowly and just sufficiently to keep the patient asleep A stomach tube should not be used unless the patient is anesthetized Artificial respiration and oxygen inhalation should be used if necessary The intravenous injection of glucose tends to combat the severe anoxia and prevents irreversible changes in the brain cells

Atropine or Belladonna This drug is used extensively and minor forms of poisoning are not uncommon In the more severe types the thirst, dry mouth and dry throat become so severe that talking or swallowing is impossible The skin is red dry hot and a rash is often present over the face and neck The pupils are widely dilated and do not react to light The pulse is weak and rapid The respirations are increased The breath sounds are dry and harsh There is restlessness insomnia disorientation, excitement hallucinations delirium, and mania These individuals are often thought to have an acute psychosis Circulatory collapse and death follow the rapidly rising temperature which may reach 108 degrees F

TREATMENT If the drug is taken by mouth give tannic acid solution, strong tea or the universal antidote (described on p 355) and induce vomiting or wash the stomach Pilocarpine in 5 mg doses is given Intravenous Sodium Amytal may be given slowly for the extreme excitement and restlessness Artificial respiration or inhalation of 5 per cent carbon dioxide and oxygen may be needed Ice bags and alcohol sponges also cold intravenous solutions should be used to control the high temperatures It is usually necessary to empty the bladder by catheterization

per cent solution of copper sulfate This should be repeated several times An ounce of Epsom salts should be administered Later a demulcent such as egg whites in water or milk is given It may be necessary to administer morphine to relieve pain

Opium Morphine laudanum, paregoric heroin codeine, Pantopon, and Dilaudid are all opium derivatives The triad of coma, pinpoint pupils and depressed slow breathing are characteristic of poisoning If the patient is seen early before coma is deep mustard in water may be tried as an emetic Usually it is unsuccessful A stomach tube should be used to empty the stomach as soon as possible Wash with a 1 1,000 solution of potassium permanganate Some advocate leaving a small amount of this solution in the stomach Give strong coffee and keep the patient awake if possible Strychnine and caffeine given as stimulants may be necessary Cold applications often stimulate respiration All such patients should be removed to a hospital which has a respirator available since artificial respiration may have to be continued for a number of hours Inhalations of 5 per cent carbon dioxide in oxygen are helpful Do not give these patients whiskey or brandy A narcotic antagonist nalorphine which is given parenterally is often very effective in reversing the respiratory depression and other toxic effects

Tranquilizing Drugs These drugs are not as dangerous as most other depressants The most common effect of overdosage is deep sleep or coma The initial depression of excessive amounts of the phenothiazine derivatives (Promazine and chlorpromazine) has sometimes been followed by restlessness and convulsions In addition respiratory depression and a marked fall in blood presure sometimes occur

TREATMENT The stomach should be emptied if the patient is seen immediately after taking the drug Otherwise, and if deep sleep is the only finding parenteral fluid administration may be the only treatment needed Amphetamine and epinephrine should not be given Barbiturates should not be used except by a physician as they may potentiate the depressive effect of these drugs

Strychnine or Nux Vomica The symptoms of poisoning are those of central nervous system stimulation The face and neck muscles feel stiff, respond violently to stimulation and within a short time there are muscle twitchings involving the entire body A mild sensory stimulus such as a noise or movement of an extremity may precipitate a convulsion This seizure is due to tetanic contraction of all the muscles and the action of the stronger ones predominates The typical position is that of hyperextension, known as opisthotonus The body is arched so that only the

appear hopeless Call a physician as soon as possible Inhalation of 5 per cent carbon dioxide in oxygen is the accepted method of treatment The carbon dioxide stimulates respiration and facilitates the oxygen exchange in anoxic states

In large industrial plants where carbon monoxide poisoning is often encountered, trained personnel including physicians are usually immediately available Utility workers and lifeguards at beaches are unusually well trained in the art of administering artificial respiration (manually) over long periods of time

Gasoline, Benzene, Naphtha Poisoning This usually results from inhalation of fumes or accidental swallowing of the chemical The symptoms resemble those of acute alcoholism The victim may become maniacal and later lose consciousness Transfer him at once to the open, remove gasoline or benzene soaked clothing apply external heat, and give treatment for carbon monoxide poisoning

Carbon Tetrachloride Inhalation or ingestion causes dizziness, headache mental confusion, and coma Death may result from respiratory or circulatory failure or from kidney or liver failure

TREATMENT If the substance was inhaled, move the victim into the open air, administer oxygen and give artificial respiration If ingested, the stomach should be emptied by lavage or emetics Alcohol should not be given The patient should be moved to a hospital as soon as possible

FOOD POISONING

Food may cause poisoning when contaminated by a toxic substance derived from a container, or when contaminated by bacteria such as the staphylococcus or a member of the salmonella group The staphylococcus may multiply in the food producing an enterotoxin responsible for the symptoms of poisoning while members of the salmonella group multiply in the bowel and produce dysentery

Substances in which toxic products occur naturally are not foods Poisonous mushrooms or toadstools normally contain a poisonous alkaloid, muscarine Certain fish also produce a product which is poisonous to man When taken as food these articles cause illness All types of food poisoning have been popularly called ptomaine poisoning and previously it was believed that food poisoning was due to putrefaction It is now known that putrefactive products are not a common cause of food poisoning

Staphylococcus Food Poisoning The symptoms are due to enterotoxin

Chloral Hydrate When combined with alcohol this is known as knock out-drops or a Mickey Finn An overdose renders the victim helpless The early symptoms are burning in the throat, nausea, upper abdominal pain, and vomiting Later there is deep stupor with cyanosis, slow breathing low blood pressure and low body temperature

TREATMENT The stomach should be emptied by an emetic or the stomach tube Keep the patient warm and give artificial respiration if needed If the patient is conscious after the stomach is emptied give strong black coffee If in a coma, give 0 5 grams of caffeine sodium benzoate subcutaneously The intravenous injection of 10 mg or 20 mg of picrotoxin may be lifesaving Intravenous glucose solution should be given to protect the liver from injury

Trinitrotoluene (TNT) Poisoning with this substance is usually seen in munition workers or members of the armed forces The poison is removed from the skin by washing with a solution of sodium hyposulfite Move the patient into the open Keep him at absolute rest Administer large amounts of water with alkaline salts, such as sodium citrate and sodium bicarbonate

Carbon Monoxide Poisoning Sufficient carbon monoxide may be inhaled to cause unconsciousness and death in a few minutes It is odorless and is found in automobile exhaust gas illuminating gas, sewer gas, and smoke from fires or furnaces In wartime especially during bombing it is important that one be on the alert for the detection of carbon monoxide arising from broken gas pipes The carbon monoxide unites with the hemoglobin of the red blood cells 250 times as readily as does oxygen and prevents the formation of oxyhemoglobin As a result the transport capacity of blood for oxygen is reduced Exposure to this gas even in low concentration over a prolonged period of time leads to an anoxemia (lack of oxygen) which may cause death The brain is most susceptible to anoxemia

SYMPTOMS OF CARBON MONOXIDE POISONING There may be headache or dizziness but usually there are no symptoms until the individual collapses, or he finds he is unable to walk He soon lapses into a stupor and dies The skin has a peculiar cherry red color in distinction to the color seen in asphyxiation from other causes

TREATMENT Get the victim into the fresh air immediately If the weather is cold use a gas free room elsewhere in the building or adjacent building If breathing has stopped or is irregular start artificial respiration (see Chapter 13) and continue until breathing is regular or a respirator arrives Artificial respiration should be continued although the case may

to the motor nervous system Weakness, dizziness, double vision paralysis of the eye muscles, incoordination, difficulty in swallowing and in breathing appear There are no sensory disturbances Constipation and retention of food in the stomach is common Death in from one to eight days results due to cardiac and respiratory failure The severity of symptoms varies greatly but at least half the victims die

TREATMENT If suspected food is inadvertently taken, the stomach should be emptied and Epsom salts should be given If or when symptoms occur the patient should be moved to a hospital where antitoxin can be given and artificial respiration can be continued as long as signs of life remain

Fish Poisoning This is of two types Physiologic products of the glands of some fish are toxic to man Certain species resembling the sturgeon used in parts of Russia and the 'tetrodons' used in China and Japan are toxic, and their ingestion may cause death Bacterial infection of canned fish may be responsible for poisoning The fish may be contaminated before packing or after the can is opened

Mussel Poisoning This is due to the ingestion by the mussel of certain small unicellular organisms which during the summer months are very numerous in the open ocean These organisms contain a strong alkaloid harmless to the mussel but very toxic to man Ingestion of such mussels is followed immediately by toxic symptoms such as a prickly sensation and numbness of the lips, fingertips and tongue Muscular incoordination (ataxia) develops and within 2 to 24 hours is followed by paralysis and respiratory failure Most of those affected die There are no antidotes Apomorphine should be given immediately to induce vomiting Artificial respiration and the respirator should be used to combat respiratory paralysis This type of poisoning has been reported from the Pacific coast Nova Scotia and the European coast

Mushroom (Toadstool) Poisoning The symptoms of severe abdominal pain, nausea, retching vomiting and diarrhea appear from a few minutes to 18 hours after partaking of poisonous mushrooms or toadstools Confusion convulsions or coma may eventually appear

TREATMENT Empty the stomach and give a cathartic immediately The victim should be moved to a hospital

Grain and Vegetable Poisoning Ergotism is the most common entity in this group It is caused by the prolonged use of grain contaminated by the ergot fungus It has occurred in epidemics in Europe Acute ergotism is manifested by slight fever weakness headache and tingling sensations

produced by the organisms growing in food Meats, cream, milk, cheese, bakery goods, and other foods kept at room temperature or in large con tainers *in a refrigerator have been the cause of outbreaks of poisoning*

Nausea, vomiting abdominal pain, and diarrhea appear within two to six hours after the ingestion of the food Often headache, muscular pain, and collapse occur

TREATMENT Vomiting and diarrhea are usually very severe and it is unnecessary to pump the stomach or give a cathartic Intravenous fluids are often necessary to combat the severe shock resulting from excessive fluid loss There is no specific treatment

Salmonella Food Poisoning This is an infectious process and usually occurs in epidemics It is due to ingestion of heavily contaminated foods The symptoms may appear within a few hours or be delayed for several days The attack is often ushered in by a chill followed by fever Vomit ing, diarrhea and abdominal pain incapacitate the victim If the diarrhea is severe, muscular pains and collapse may follow due to loss of large amounts of fluid or blood The symptoms may be mild or severe with extreme prostration The diagnosis can be established by culturing the causative organism from the blood and stools or later by blood serum reactions In these outbreaks, a search should be made for a carrier among the food handlers

TREATMENT The patient should be kept at rest and given fluids as soon as nausea and vomiting subside If diarrhea has been severe, two teaspoonfuls of paregoric or morphine sulfate ¼ gr subcutaneously will usually check the loss of fluid Heat to the abdomen bed rest and re striction of food are advised A patient in collapse should be kept warm, in such cases medical aid should be obtained at once since these patients need intravenous saline solution and plasma to combat the loss of fluid The patient should be left recumbent if he feels faint Antibiotics may be needed but should be prescribed only by a physician

Botulism This poisoning results from the ingestion of canned foods contaminated by botulinus spores The canning sterilization does not destroy the spores included with the vegetables or meat These change to the vegetative form which produce a true toxin Home canned vegetables are especially likely to be contaminated unless they are sterilized in a *pressure cooker* Canned foods which are softened, show bubbles or have a rancid odor should not be used Uncooked foods or fresh foods do not contain this toxin

Symptoms appear in from 4 to 48 hours These are mainly referable

be accomplished if a close watch is maintained Care in maintaining a clean, safe supply of drinking water and emergency rations will help in keeping down the incidence of gastrointestinal disorders and infections due to the various dysentery organisms Immunization against typhoid, paratyphoid, diphtheria, and smallpox should be given to those portions of the population exposed to disruption of their normal mode of living

Any child or individual with a high fever, rash, or other skin lesion should be isolated or kept from the rest of the group A physician should be called to see the patient, persons exposed should be isolated when the proper diagnosis has been made Individuals with acute upper respiratory infections should stay as far away from others as possible They should cough or sneeze into a handkerchief Infants and young children who have not had whooping cough should be immunized Those who come in contact with patients having rashes, skin lesions, sore throats, or fever should wash their hands carefully after waiting on them Attendants should not allow such a patient to breathe or cough in their faces

CHILLS

The chilly sensation arising from a cold skin is usually due to a deficient circulation through the skin vessels which stimulates the cold end organs This is followed by an increased muscle tonus with increased heat production A true chill often is indicative of the onset of an acute infectious disease or of a foreign protein reaction as in a transfusion of incompatible blood It is accompanied by clonic muscular contractions The skin feels cold the teeth chatter and the patient shakes or shivers The cold skin is due to vasoconstriction which results in a decrease in blood flow to the skin Transfer of heat to the body surface is in this way decreased The extra heat produced by shivering or shaking is stored and the body temperature rises Eventually the skin vessels dilate, the skin warms up and the chill stops Perspiration follows and evaporation facilitates the loss of the stored heat Thus at the start of the chill the skin is pale and at its termination it is flushed warm and red

The *treatment* of a chill consists of the application of heat warm blankets hot water bottles or pads and administration of warm drinks An amyl nitrite pearl (perle) broken and inhaled or nitroglycerin under the tongue often dilates the skin vessels and warms the skin thus terminating the chill *Application of heat is especially indicated* in post transfusion chills or in serum reactions In general, any patient who feels chilly or has a definite chill should be warmed up since the increase in blood

in various parts of the body Diarrhea with nervous symptoms such as spasm of the muscles and occasionally convulsions occur Mental depression is common

In the chronic form of *poisoning*, there is gangrene involving the fingers, toes, nose, or ears, and occasionally convulsions

Treatment consists of elimination of the offending food Nausea and vomiting may be relieved by 0 14 mg atropine sulfate and the nervous symptoms by 10 ml of a 10 per cent solution of calcium gluconate given intravenously

Potato Poisoning This is rare though a number of outbreaks after the use of sprouted potatoes have been reported The toxic substance is salamin, produced by bacterial action Chills, fever, headache vomiting diarrhea, colic, and prostation are the symptoms Some patients become jaundiced All recover

Treatment consists of emptying the stomach and bowel

Lathyrism or Lupinosis This has been reported in North Africa and India where chickpea meal is used in the preparation of food The condition is a spastic paraplegia or paralysis of the lower extremities

Favism This type of poisoning is rather rare and is reported most frequently from Italy Sicily and North Africa It is caused by inhalation of pollen from a bean plant, *Vicia fava* when it is in bloom, or by ingestion of the bean Acute anemia with jaundice, bloody urine and hemoglobinuria are the presenting findings The condition is due to sensivity to the bean protein

Treatment consists of blood transfusions If acute anaphylactic shock occurs epinephrine 1 ml of 1 to 1 000 solution given subcutaneously is of value if given intravenously the dose must be reduced to a few minims

Akee Poisoning This illness of Jamaica also known as the vomiting sickness is caused by eating immature or spoiled akees The symptoms are vomiting convulsions and coma The mortality is high Alcohol followed by an emetic has reduced the death rate

CONTAGIOUS DISEASES

The problem of contagion is one which increases in importance as people are together under abnormal environmental conditions In air raid shelters or temporary quarters of any type the exposure incident to contagious or infectious disease is increased and there is probably also a lowering of resistance on the part of the individual While efficient isolation of suspected individuals is impossible under such conditions much can

Inhalation of 5 per cent carbon dioxide in oxygen may alleviate the mental confusion Do not subject frostbitten tissues to heat or friction Local effects of cold are considered in Chapter 8

STARVATION

An individual deprived of food derives energy first from his carbohydrate stores (glycogen) Then fat is utilized, and eventually the body proteins are metabolized If plenty of water is available, life is maintaned for a number of weeks The rate of destruction of body tissue is dependent on the activity of the individual

During the first few days of starvation the subcutaneous fat and other fat deposits in the body suffer There is also a loss of extracellular water Later the muscle tissues are destroyed with loss of intracellular water The rate of muscle destruction is dependent on the availability of carbohydrate and fat When the stores of carbohydrate fail, the body utilizes acetone bodies for sources of quick fuel When these are no longer available, the muscles and other proteins are the sole source of energy

The symptoms of inanition are weakness, loss of weight, lethargy and inability to tolerate exertion The symptoms of specific vitamin deficiences do not occur in starvation when no food is available After the first few days hunger is not noted The pulse and respirations grow gradually weaker complete exhaustion supervenes and the victim frequently dies of pneumonia

Vitamin deficiency states occur when certain foods are available in limited quantities but constitute an incomplete diet As vitamin stores are exhausted the individual develops single or combined deficiency states

Treatment The patient should be kept at absolute bed rest Intravenous dextrose solutions furnish immediately available energy Their use should be continued until the victim is able to swallow without danger of aspirating food into the lungs Nutritious liquids are first given by mouth in fairly small quantity later readily digestible food is given The administration of vitamins especially B and C should be started at once They can be given by hypodermic injection until the victim is able to take them by mouth Protein can be given intravenously in the form of a protein hydrolysate

flow through the skin incidental to the storage of heat or decreased loss of heat, stops or diminishes this chilly sensation Warm blankets, newspapers, or coats should be placed under the individual as well as over him A patient can lose a tremendous amount of heat through conduction if he is lying on a cement floor or the cold ground Do not burn the patient Always test a hot water container on the forearm, especially if it is metal *All hot water bottles or flatirons should be wrapped with cloth or paper* so that they do not come in immediate contact with the patient s body

The treatment described above is largely symptomatic Since chills are usually caused by infections of a serious nature, the patient should seek medical care, and examination should be performed to find the cause so that specific therapy may be instituted

EXPOSURE TO COLD

The effects of cold on the individual are of great interest at the present time With subzero temperatures within a few miles of the earth s surface, even at the equator, the problem becomes a universal one

The symptoms of exposure to cold are well known There occurs first a sensation of chilling with the reaction of goose pimples " If heat production is increased sufficiently or if heat loss is reduced by protection of clothing or shelter from wind the reaction stops Otherwise the chilling is accentuated and there is a progressive fall in the temperature of the extremities They become stiff and numb Mental changes similar to those seen in anoxic states follow shortly Errors in judgment and in ability to make decisions are among the early defects The heat loss from the trunk leads to further constriction of the vessels of the extremities and to freezing of the hands feet ears or nose in spite of apparently adequate protection If the trunk is warmly clothed so heat loss is at a minimum the blood flow through the extremities is maintained, and frostbite even at low temperatures may be minimized Adequate clothing especially of the trunk, is very important in withstanding the cold The clothing must not be tight Lanolin rubbed into the skin twice daily is said to be helpful

Treatment The exposed individual should be warmed slowly He should be moved into a protected room and the wet and frozen clothing removed The room temperature should be raised gradually and the patient warmed to a degree just below body temperature He should not be exposed directly to hot radiators or blasts of heated air Artificial respiration should be used if necessary Warm stimulating drinks add heat internally

22

The Prostrate Patient

WARREN H COLE

The term prostrate is a generalized one used to denote collapse of some type or other The patient usually is so ill that he is unable to stand He may or may not be unconscious, and likewise may or may not respond intelligently to questions If he is markedly confused mentally, the condition is spoken of as *delirium* If he is incapable of any sensory perception or motor function, the term *unconscious* or *comatose* is applied to his mental state The terms unconscious and comatose are synonymous as far as the patient s mental incapacity is concerned, but the term *coma* is usually applied when the patient is unconscious because of physiochemical reasons, such as diabetic coma and coma from uremia (kidney disease) All patients in shock will be prostrate, but not unconscious until late severe stages

The prostrate patient will afford the first aid worker an extreme amount of difficulty in the extension of intelligent care largely because the diagnosis will frequently be so difficult There are so many conditions which will produce this type of physical and mental disability that even trained physicians have difficulty at times in arriving at the correct diag nosis and intelligent therapy Naturally one of the difficulties in reaching a diagnosis will lie in the fact that frequently the patient is incapable of furnishing any history If the patient is conscious, he will very often be able to supply the diagnosis through the history It is naturally important that the diagnosis be made as soon as possible, because on many occasions life will depend upon intelligent immediate action

Most of the conditions producing prostration are so complicated, as is also their first aid therapy that the discussion and treatment presented in this chapter are largely directed toward physicians or those having medical training *The aid of a physician must be sought at once*

DEHYDRATION

Water holds the body salts, proteins and other solutes at a level exerting a constant osmotic pressure Theoretically, if water should be added to the body fluids there would be a dilution and a lowering of the osmotic pressure If water should be abstracted the osmotic pressure would rise All of the physiologic reactions, and indeed the preservation of life are dependent on the maintenance of a constant osmotic pressure Practically secondary adjustments within the organism prevent any significant variations in the body fluids due to the addition or abstraction of water

Water is required for the elimination of heat It is vaporized from the skin and lung surfaces If the individual is engaged in hard work he develops extra heat which has to be eliminated If he is surrounded by hot air he will have to vaporize more water, since heat loss by radiation is reduced Water requirements are then increased by work and exposure to hot conditions Water is also used to carry out through the kidneys and bowels the end products of protein metabolism and salts of various types

Thirst is a symptom of water deficiency but it is not a guide to the quantity required The dry parched tongue, the dry scaling skin which wrinkles easily and the sunken soft eyeballs indicate that the extracellular supplies of water have been requisitioned and are now reduced In severe dehydration states the individual s tongue is so dry that he is unable to chew food Swallowing becomes impossible The urinary output is decreased to such an extent that urination is painful due to deposition of salts in the bladder At this time if the blood volume were measured it would be found reduced

Treatment It is obvious that individuals engaged in work will require more water in hot than in temperate climates Thirst is not a reliable guide to the amount of water required Chewing of gum or the holding of pebbles in the mouth promote the flow of saliva and frequently reduce thirst Water incorporated with food which contains salts of various types is absorbed more readily than the same quantity of water taken alone Further, the salts tend to expand the blood volume and hydrate the tissues

The more active treatment of dehydration consists of the intravenous injection of physiologic salt solution with or without glucose When the dehydration is severe it is often best relieved by the addition of base, in the form of sodium lactate to the fluids The increase in urinary output and the changes in the appearance of the tongue are satisfactory indices of the adequacy of the treatment The appearance of edema denotes the use of excessive quantities of salt solution

serious depression of respiration In many instances these victims may be revived by artificial respiration (See Chapter 13)

7 Poisoning Prostration due to poisoning is usually the result of suicidal intent Mercury (bichloride), sedatives (barbital compounds), and morphine are the drugs commonly used Details of this complication may be found in Chapter 21

8 Miscellaneous Causes There are numerous miscellaneous conditions which may cause acute prostration In hot weather, heat exhaustion may be a likely cause There are numerous types of insanity which may produce mental confusion and prostration Epilepsy which may produce total unconsciousness associated with convulsions is not infrequent Hysteria, which is a functional mental disease presumably not caused by an organic lesion, may be encountered Prostration may accompany serious acute infections, such as meningitis and pneumonia But the first aid worker will rarely encounter prostration of this type (i e , due to infection), since the patient will have had symptoms for a variable length of time before prostration occurs and will not venture out However, collapse might occur (though knowing of his condition) if he overtaxed his weakened physique It must be recalled that fainting (as discussed in Chapter 21) is a very common cause of prostration

PROCEDURES IN EXAMINATION OF THE PROSTRATE PATIENT

1 **Observation and Inspection** Careful observation of the surroundings in respect to the patient will lead to the correct diagnosis in a great many instances Perhaps the first observation to be made is to determine whether or not the patient is in need of immediate aid, such as control of hemorrhage and relief of respiratory obstruction Discovery of a dead person in the ruins of a wrecked car is obvious proof of an automobile accident, but this circumstantial evidence, conclusive as it may seem does not disprove the possibility of the person s death *before* the accident For example, he may have been shot by gangsters, or may have had a heart attack If the patient is still alive it is obviously important from the standpoint of therapy that the proper diagnosis be made if dead, this responsibility does not concern the first aid worker since the diagnosis will be made by the coroner However this factor is mentioned to illustrate the many complications which must be studied in accident cases

Observation of the surroundings may reveal evidences of a struggle

CAUSES OF PROSTRATION

1 Injury or Disease of the Brain Perhaps the most common cause of prostration is a lesion of the brain Of this group, injury is one of the most important, insofar as a fracture of the skull with associated laceration and hemorrhage into the brain is so frequently sustained in automobile accidents, etc Another common cause of acute prostration is apoplexy (commonly known as a stroke), which is produced by a rupture of a blood vessel into the brain usually occurring in elderly people, it is discussed in Chapter 21 Occasionally, rupture of blood vessels is associated with tumors of the brain producing unconsciousness or serious mental disturbances

2 Heart Disease During the past two or three decades, it has been apparent that heart disease is becoming more frequent and is attacking younger people than were afflicted by it a few decades ago One of the important causes of acute prostration due to heart disease is obstruction of the coronary artery due to thrombosis or arteriosclerotic plaques (angina pectoris) as is discussed in Chapter 21

3 Shock The development of shock secondary to severe injury with or without hemorrhage is of course, common in these days of advanced mechanization

4 Acute Alcoholism When too much liquor is consumed mental confusion will be encountered and if the quantity is sufficient total unconsciousness will develop

5 Diabetic Coma Attacks of unconsciousness resulting from uncontrolled diabetes are not as common as before the introduction of insulin However they still occur partly because patients frequently are unaware of the presence of the disease or fail to adhere to their diet as prescribed by the physician Diabetic coma results from too much sugar in the circulating blood but it must be remembered that the opposite condition (that is too little sugar in the blood) resulting from too much insulin or from tumors of the pancreas may likewise produce prostration

6 Asphyxia This condition may be produced by numerous causes perhaps the most common of which are carbon monoxide poisoning and near drowning Usually the asphyxia resulting from carbon monoxide is produced by exposure to exhaust fumes in small garages where automobile motors are running Unfortunately suicide is frequently attempted by carbon monoxide asphyxiation achieved by turning on a jet in a gas stove or exposing oneself to fumes of a motor Electric shock may cause

4 Detailed Examination After a preliminary examination is made, and the urgent first aid needs, such as control of hemorrhage and establishment of a satisfactory airway, are taken care of, the first aid worker should proceed with a detailed examination as described in Chapter 2 This examination will be directed particularly toward discovery of fractures (by detection of deformity or abnormal mobility), hemorrhage from the ears, contusions about the body, and other manifestations Since it is much more difficult to arrive at a correct diagnosis in the absence of a history, it is obviously essential that the examination be as thorough as possible thereby taking advantage of every possible bit of information discernible

TREATMENT

The details of treatment of the various types of conditions which may be encountered are given elsewhere but are summarized here because intelligent treatment of unconscious or partially unconscious patients is so rarely performed by first aid workers and even physicians It is, of course, possible to render helpful aid in the absence of a correct diagnosis, although definitive treatment cannot be carried out without an accurate diagnosis obviously, the responsibility of the first aid worker is largely terminated after he has completed first aid therapy Establishment of an accurate diagnosis and performance of definitive treatment are in reality responsibilities of the physician As stated previously, the first aid worker should be sure that a doctor and an ambulance have been called

As emphasized elsewhere the first consideration is to control hemorrhage which is done according to instructions given in Chapter 7 Practically as important will be relief of any respiratory obstruction There may not be any foreign bodies obstructing the pharynx yet it may be obvious that the patient has an obstruction to breathing As described in Chapter 13, this obstruction may be due to the fact that the tongue has fallen back against the posterior part of the pharynx This happens in unconscious patients and may be so acute as to produce death by suffocation Another condition which may result in serious obstruction due to the tongue falling back against the pharynx is a fracture of the jaw which allows shortening of the structures in the floor of the mouth in a backward direction If the patient is unconscious and having a respiratory stridor he should be changed from the supine position to a prone or semiprone position This in itself may be sufficient to restore an adequate airway If not, the first aid worker should elevate the jaw anteriorly by

or weapons The victim's clothing may be torn, indicating that the cause of his prostration was due to violence and not a medical disease Obviously, the presence of wounds would be proof of violence Regardless of whether or not there is evidence of injury, the first aid worker should smell the patient s breath If there is alcohol on the patient s breath acute alcoholism may or may not be a prominent factor in the patient s prostration If the patient has an acetone breath (fruity odor), he may be suffering from a condition such as diabetic coma Burns on the lips might indicate that he had taken poison

2 History and Determination of Mental Status The first aid worker may be able to make a diagnosis if history is obtainable from the patient or bystanders However, the patient may be totally unconscious, if so, no history will be obtainable from him If he is merely confused or delirious, history may be obtainable but it may be inaccurate It is important therefore that the degree of mental confusion be analyzed as accurately as possible in order that proper evaluation of the patient s replies to questions be made The type of mental confusion and delirium may be very important in arriving at a diagnosis For example the euphoria and typical speech difficulties encountered in an intoxicated person are fairly easy to recognize The speech center of patients who have had an apoplectic stroke is frequently damaged by the hemorrhage in the brain They may appear conscious but are unable to talk on other occasions they are observed to make strenuous effort to talk but succeed only in mumbling certain words or parts of words Patients with uremic (diseased kidney) coma frequently talk a great deal pronouncing words fairly accurately but speak in a completely irrational manner

3 Determination of Circulatory Status The state of the patient s circulation should be determined immediately so that shock, if present may be treated promptly The first aid worker should feel the patient s pulse count the rate and feel the skin for increased perspiration and decrease in temperature He should likewise take the patient s blood pressure if a blood pressure machine is available These examinations will rapidly detect the manifestations of shock which have been described elsewhere An irregularity in the heart rate would suggest that the collapse was due to an acute cardiac accident such as coronary occlusion If cyanosis (bluish discoloration of skin) is present, there will be indication of either respiratory obstruction or failure of the circulatory apparatus This failure in the circulatory mechanism may be due to a primary heart disease to respiratory obstruction or to acute trauma of sufficient degree to interfere with the heart and its circulatory function

23

Miscellaneous Conditions Frequently Requiring First Aid Care

WARREN H COLE

In this section will be included numerous conditions which in themselves are not strictly emergencies but are urgent and at times require first aid care, particularly when a physician is not immediately available They scarcely belong in a book on first aid but are included because of their frequency and interest to the public

Allergy and Anaphylaxis Allergy manifests itself in many ways The common diseases such as hay fever, asthma, and hives are in reality, types of allergy which in general represent sensitization of the patient to some substance This offending agent may be plant pollen, food and in fact most any conceivable substance Hay fever and asthma will not be discussed since they are chronic diseases

HIVES As stated above, hives are produced because of sensitization When they occur in supposedly healthy people they are usually secondary to food Sea food is a very common etiologic factor The hives occur a few hours to a few days after exposure to the offending substance They develop as indurated areas which itch but rarely produce pain Occasionally they develop about the face and produce moderate swelling of the lips, eyelids etc , although these swellings usually are known as angioneuroedema a definite manifestation of allergy Sensitization of this mild type usually clears itself spontaneously and no radical therapy is indicated Application of calamine lotion containing 1 per cent phenol or 1 per cent menthol is quite effective in relieving the itching Epinephrine (Adrenalin) and antihistamine compounds may be helpful

SERUM REACTION Serum reaction manifests itself in one of two ways The most common manifestation and by far the less serious is the development of hives two to six days after the administration of a serum such as that given for lockjaw or diphtheria In addition to the hives such manifestations as nausea vomiting mild fever and restlessness likewise

pressing the ramus of the mandible forward This is usually effective in establishing an adequate airway Secretions should be removed from the mouth It may be necessary to insert some sort of makeshift mouth gag such as a stick of wood wrapped with a handkerchief to obtain access to the mouth and perhaps sponge out an excess of saliva, vomitus, etc (see also Chapter 17) False teeth, loose dental plates, etc, should be removed in the unconscious person lest he aspirate them back into the larynx If respirations still appear to be obstructed, the mouth may be pried open with the stick protected with gauze and the tongue grasped by the fingers covered with gauze to aid in traction Pulling the tongue forward in this manner will almost certainly remove any obstruction in the posterior pharynx except that produced by foreign bodies The patient must be watched closely for vomiting if he is unconscious, since vomitus is so apt to be aspirated Placing the patient in a semiprone position will aid considerably in prevention of aspiration of vomitus, but the first aid worker should be prepared to sponge the mouth out repeatedly and remove food particles which might be aspirated back into the trachea

If there is no evidence of shock the patient will usually be more comfortable if his head is elevated slightly If he is in shock the head must be kept down level with the body, and in fact preferably, the head and chest should be lower than the lower extremities

Manipulate the patient as little as possible lest injury sustained by him be exaggerated It is usually desirable however to move the patient to a comfortable position and to correct obviously awkward positions of extremities and other parts created by the accident

Keep the air circulating about the patient particularly if he is having trouble breathing or is warm It may be necessary to fan him or open windows and doors in case the accident has occurred inside a building If he is obviously seriously injured and exposed to cold atmosphere, he should be kept warm by applying blankets over and under him Hot water bottles are dangerous because unconscious or semiconscious people will not detect the heat of a hot water bottle which may be too hot Chemical heating pads which will generate heat with the addition of a few milliliters of water may be very useful and are safe if directions are followed regarding the amount of water to be added

While awaiting the ambulance or physician the first aid worker may proceed with the splinting of fractures regardless of whether or not the patient is conscious Before the patient is transported the fractures should be immobilized Instructions in this type of therapy will be found in Chapter 11

of the actual lesion, once it develops, is not so effective However, certain remedial agents are of distinct benefit and should be used In the early stages of the disease the application of calamine lotion containing 1 per cent phenol or menthol will be quite effective in relieving the itching which at times is extremely aggravating In the exudative or ulcerative stages the application of 10 per cent aluminum acetate is advisable

Sea or Air Sickness The mechanism of production and the manifestations of these two types of sickness are relatively the same, although the former occurs at sea whereas the latter occurs in the air In either case it is the reeling and tossing of the boat or plane and the deleterious action on the semicircular canals of the ear which give rise to the symptoms Unquestionably, fear of development of the condition, and neurotic tendencies increase the severity of the symptoms and are actually responsible for the development of some However, in most people seasickness or airsickness is a true condition not to be spoken of as resulting from neurotic characteristics

The patient is apt to feel a heavy uncomfortable sensation in the upper abdomen followed soon by *intense* nausea Salivation is apt to develop Vomiting usually occurs and at times is so severe that the patient can retain no food Vertigo is fairly common The skin is pale and cold and frequently covered with a ' cold sweat There is mental and physical lethargy In serious cases there may actually be a drop in the blood pressure with tachycardia (elevation of the pulse rate)

Dramamine is usually effective in preventing sea or air sickness and often effective in relieving it if given after the sickness develops Fresh cold air is usually helpful Occasionally an abdominal support applied rather snugly will help relieve symptoms Alcohol may relieve the symptoms for a short time but usually aggravates them later on, and for a much longer period than the relief obtained Alcohol is, therefore, contraindicated Sedatives such as phenobarbital (gr ½), are usually helpful this dose may be repeated two or three times per day

Altitude Sickness The manifestations of altitude sickness slightly resemble those produced by air or sea sickness but are produced by a different mechanism As one ascends into the air the percentage of oxygen becomes less and the oxygen needs of the body are not met completely Symptoms usually develop in the average individual if he goes higher than an altitude of 13 000 or 14,000 feet Early symptoms are weakness, headache, vertigo nausea, occasionally vomiting prostration and mental confusion The patient usually has difficulty in getting his breath which is explained not on the basis of obstruction to the respiratory system, but

appear The intramuscular injection of 5 or 6 minims of epinephrine (Adrenalin) usually causes rapid subsidence of the symptoms

The severe reactions (anaphylaxis) following injection of serum are very rare, but are extremely serious They usually come on within a few seconds or minutes after the injection and require immediate therapy to prevent lethal outcome The patient usually complains first of pain in the chest and difficulty in breathing The pulse may be rapid and irregular The patient becomes weak pale and may actually collapse on the floor *The blood pressure may drop and in fact be unobtainable* The best treatment for patients with such reaction is the administration of epinephrine Such patients may receive 8 to 15 minims of epinephrine intravenously It has been administered into the heart with markedly beneficial and dramatic effects This dose may be repeated in an hour or two if blood pressure fails to rise

Although such reactions are rare, they are sufficiently serious to make it necessary to determine whether or not a patient who is to receive serum might be sensitive to it In sensitive patients the administration of a fraction of a drop into the skin will produce a tiny wheal indicating sensitivity

Poison Ivy and Poison Oak *One of the most important phases of these* conditions is the *prevention of the diseases* after exposure or contact with either of the two plants Frequently, people discover the presence of poison ivy or poison oak during their trip into the woods, but only after they have come in contact with it Proper treatment if resorted to within a few hours, will prevent development of the disease One of the simplest and most effective procedures in preventing the skin lesions after exposure to either of the two plants named above is washing the contaminated areas with soap and water After thoroughly washing these areas with soap and water gently washing it with some solvent such as benzene will add to the effectiveness of the prevention

The skin lesion develops 12 to 48 hours after contact with the plant and manifests itself first as reddened areas which itch considerably Very soon small blisters or vesicles appear These vesicles may rupture or be ruptured by scratching and are apt to become infected In severe cases, actual ulceration may be present The condition is spread by the patient who scratches an affected area and transfers some of the poisonous material to other areas Considerable edema of the subcutaneous tissue may develop under the affected areas In serious cases the condition may last for weeks in spite of seemingly adequate treatment

Although the prophylactic treatment is very effective, the treatment

Thrombosis of a hemorrhoid usually occurs fairly rapidly and commonly without obvious cause Severe pain develops and an indurated area represented by the thrombosed hemorrhoid may be palpated The pain is usually so severe as to cause complete, or at least partial, disability The recumbent position with applications of an ice bag to the affected area affords relief, but with conservative *treatment* of this type, it will usually require three or four days for the pain to subside A much more effective method of eradicating the symptoms and the condition is to have a physician incise over the thrombosed hemorrhoid and express the blood clot Invariably this affords complete relief A small dressing is applied and the patient allowed up as usual

Prolapsed hemorrhoids usually occur only in the severe cases in which there is a redundancy of mucosa This prolapse occurs during bowel movement, but usually is reduced spontaneously At other times the patient obtains reduction by pressure with the padded finger On certain occasions reduction by the patient may be unsuccessful In this case the patient should be put to bed with the buttocks elevated and an ice bag applied to the perineum The administration of sedatives such as aspirin grains 10 and phenobarbital grain ½ should be given in an attempt to obliterate spasm of the rectal sphincter which so commonly prevents reduction of the mass Ordinarily it is advisable to have the mass reduced early by a physician before it becomes edematous and irreducible In either event an operation will usually be necessary ultimately

Furuncles (Boils) A furuncle or boil is an infection of a hair follicle It develops gradually and within two or three days manifests itself as an indurated, tender conical or hemispherical area with a red surface A hair will be seen in the center After several days a yellow point will be seen in the center which represnts an accumulation of pus

Treatment consists of several phases including immobilization of the infected part, and application of hot wet dressings, later it may be necessary for the boil to be opened by a physician Local application of sulfathiazole ointment (5 per cent) is of value insofar as it keeps the skin soft and minimizes the spread of the bacteria (staphylococcus) to other areas of the skin Hot wet dressings are effective In severe cases administration of chemotherapeutic agents such as penicillin or Aureomycin will be indicated *Do not squeeze a furuncle*

Hiccough This is caused by a sudden spasm of the diaphragm It is observed very commonly but only rarely is it serious Occasionally it develops with moderate severity in patients who have had abdominal operations but it may develop in healthy people If it does not disappear

on the rarefied atmosphere which deprives the body of sufficient oxygen He may actually be cyanotic

The most effective method of treatment is to have the patient return to a low altitude The administration of oxygen will likewise be effective in correcting the symptoms The patient should be put to rest preferably in the recumbent position and should confine his activities to a minimum

Toothache Toothache is usually caused by a cavity in a tooth, by an abscess developing at the root Obviously preventive measures will minimize the incidence of toothache regular observation and care by a dentist will result in the discovery of small cavities which can be filled thus preventing toothache and further decay

First aid treatment of toothache caused by a cavity consists of cleaning out food particles from the cavity and packing it with a small bit of cotton saturated with oil of cloves Naturally a dentist should be consulted relative to filling the cavity When the toothache develops because of an abscess at the root there is of course, much more difficulty in obtaining relief A hot water bottle or an ice bag should be applied a hot water bag is preferable but if infection is trivial an ice bag may be more effective in relieving pain If the pain persists and particularly if swelling of the cheek develops there is usually an indication that infection has broken through the tooth socket This may require drainage by incision Such conditions should, of course, be seen and cared for by dentists or physicians

Earache Pain in the ears is more common during childhood than in adult life It is usually produced by an infection in the middle ear This infection frequently obtains access to the middle ear through the eustachian tube which connects with the pharynx or throat Blowing the nose vigorously particularly when the individual has a cold tends to force infected material up the eustachian tube and thus instigate an infection

First aid *treatment* consists of application of a hot water bottle covered with a towel to the affected ear Instilling a drop or two of warm oil (e g mineral or olive) almost always affords relief unless the infection is progressing on to actual suppuration In this case it may be necessary for the physician to incise the eardrum for drainage of the pus to the outside Sedatives such as aspirin should be given but if the pain is not relieved after several hours a physician should be called

Thrombosed or Prolapsed Hemorrhoids Hemorrhoids are extremely common, being present to a mild degree in perhaps 25 per cent or more of adults past the age of 40 Complications such as bleeding from hemorrhoids, thrombosis or prolapse are fairly common

piration, will be the most prominent manifestation It should be remembered, however, that if a large foreign body enters the esophagus and can not be swallowed into the stomach, a moderate amount of respiratory obstruction may be evident When the foreign body is lodged in the respiratory tract, first aid treatment may be entirely ineffectual unless it happens to be lodged deep in the pharynx (throat) where it could actually be lifted out with the finger Naturally, it could not be reached with the finger if it were in the larynx or below The patient, of course, should be seen by a physician immediately Shifting the position of the patient with his head down is sometimes done, but is extremely dangerous since a foreign body may be dislodged to a position where it completely blocks the respiratory tract Further details regarding respiratory obstruction may be found in Chapter 13

Most foreign bodies which are swallowed into the stomach are relatively harmless ones such as marbles or pennies Fortunately, these foreign bodies being round and smooth will pass readily through the intestinal tract without producing harmful effects More serious foreign bodies are open safety pins This is a remarkably frequent type of foreign body, particularly in infants Although it might appear impossible for an infant to pass an open safety pin, yet experience has taught us that in most instances the pin will actually pass through the entire intestinal tract without producing serious harm On some occasions, the pin may lodge at certain points and actually penetrate the wall of the intestine When this happens a local abscess will develop which may actually spread into a general peritonitis

The *treatment* of patients who have swallowed foreign bodies need need not be of an emergency nature except that foreign bodies with sharp points may occasionally require operation to remove them to prevent perforation of the intestine One of the most important features in the treatment of swallowed foreign bodies is that *cathartics must not be administered* The administration of cathartics may increase peristalsis so much that the sharp points of the foreign body may actually penetrate the wall of the intestine In general the patient is allowed water and soft food on the assumption that the foreign body will be passed through the rectum If the foreign body is of such a nature that there are sharp points on it a physician should naturally be consulted to determine whether or not operation is indicated for removal of the swallowed object Naturally the stool should be watched to determine when and if the object is passed

after a few minutes numerous home remedies may be tried In the mild forms usually seen in healthy people these remedies should suffice Often swallowing a glass of cold water slowly will stop the hiccough At times pulling out the tongue, hitting the affected person on the back, or surprising him in some way will cause the hiccoughs to disappear Rebreathing into a paper bag is effective sometimes If these procedures do not help, a physician should be called Intravenous injection of procaine (by physicians only) usually affords relief

Caisson Disease *This is a condition encountered in caisson workers* or divers when they have been subjected to decompression too rapidly The cause of the symptoms is liberation of bubbles of nitrogen into the tissues During compression the blood going through the lungs becomes saturated with nitrogen this results in absorption of nitrogen by the tissues When the pressure is released, or when the individual returns to normal atmospheric pressure the tissues give up the nitrogen to the blood stream If this nitrogen accumulates in the formation of bubbles, symptoms develop The nitrogen is found first in the venous blood and fatty tissues but bubbles may actually develop in bones Within 30 minutes to 2 or 3 hours after leaving the caisson symptoms will develop unless decompression has been effected slowly Common symptoms are severe pains in the extremities frequently associated with nausea vomiting and abdominal pain Weakness of the lower extremities is a common complaint and has given rise to the lay term the bends" This weakness may progress to actual paralysis followed by coma and death

The most effective treatment is to submit the patient to pressure as is routinely done in a pressure chamber when the worker returns from the caisson When he is subjected to increased pressure which is released *slowly over a period of hours the symptoms usually disappear Symptom*atic treatment including hot fomentations morphine, etc may be indicated

Swallowed Foreign Bodies Emergencies arising from swallowed foreign bodies occur much more commonly in children than in adults because children so commonly insert various objects in their mouth during play One of the most important features during such an emergency is to determine whether or not the foreign body has been swallowed into the stomach or has been aspirated into the respiratory tract If it has been aspirated into the respiratory tract it may lodge in the larynx in the trachea at the bifurcation or even in the smaller bronchi Usually it will not be difficult to differentiate the location of the foreign body When it has lodged in the respiratory tract difficulty in breathing consisting of obstruction to res-

Table 4 Source of Compensable Work Injuries

Source of Injury	All Disabling Injuries %	Fatal Permanent Total Disability %	Permanent Partial Disability %	Temporary Total Disability %
Handling objects manual	24 4	11 2	18 8	28 7
Falls	18 0	16 5	16 3	19 2
Struck by falling moving objects	10 1	6 5	13 4	7 8
Machinery	9 8	3 0	15 2	6 1
Vehicles	7 6	22 3	6 6	8 0
Stepping on striking against objects	6 6	0 8	7 3	6 1
Hand tools	6 5	1 7	7 4	6 0
Electricity, heat explosives	3 1	8 9	2 7	3 3
Harmful substances	2 6	10 4	1 7	3 1
Elevators hoists conveyors	2 3	4 2	2 8	1 8
Engines motors	0 4	0 2	0 7	0 3
Others	8 6	14 3	7 1	9 6
Totals	100%	100%	100%	100%

perience First aid therefore as applied in industry differs only in that it is more highly organized for the care of injuries Where a large number of workers are concentrated in a relatively small plant area well-equipped First Aid Stations staffed by nurses and doctors are provided This staff will train first aid teams in various work areas and disperse emergency stretchers and supplies throughout the plant The training stresses the importance of prompt proper care for all injuries and when and how to move the seriously injured Workers become more safety conscious when participating in such periodic training

The pattern of organization for industries such as transportation will differ in that there will be greater dependence on the individual to use the nearest medical and hospital facilities available when accidents occur

In the mining industry first aid and mine rescue work are taught hand in hand It is occasionally necessary for a medical attendant to be transported in to the scene of an accident while the release of an injured miner is progressing The majority of casualties however are given first aid by their group and brought out to the first aid station or hospital

24

First Aid in Industry

BURTON C KILBOURNE AND EUDELL G PAUL

The value of efficient first aid for the injured has been recognized in industry for many years In fact the First Aid Service was the earliest form of the now highly organized Industrial Medical Department This emphasis on first aid by industry might lead one to believe that industrial accidents are disproportionately common In the past this may have been true In recent years however there have been more injuries to workers away from work than when on the job

Table 3 All Deaths and Injuries of Workers—1957

	DEATHS	INJURIES
All accidents	46 000	4 400 000
At work	14 200	1 950 000
Away from work	31 800	2 450 000

(From National Safety Council Accident Facts, 1958)

The at work injuries indicated above cost industry and the employees an estimated four billion dollars An employer wishing to lower this cost concentrates on accident prevention and provides an efficient First Aid and Medical Service Good treatment will save some lives shorten time away from work and lessen permanent disability Employee moral is enhanced by the realization that expert treatment will be received should injury occur

Statistically it is found that the construction, transportation and mining industries have the highest incidence of injuries while trade manufacturing and utilities show a somewhat lower frequency rate Source of injury studies (Table 4) provide information for preventive programs and depict to the first aid worker the relationship of accident mechanism to severity of injury

There are few injuries in industry not duplicated in nonindustrial ex-

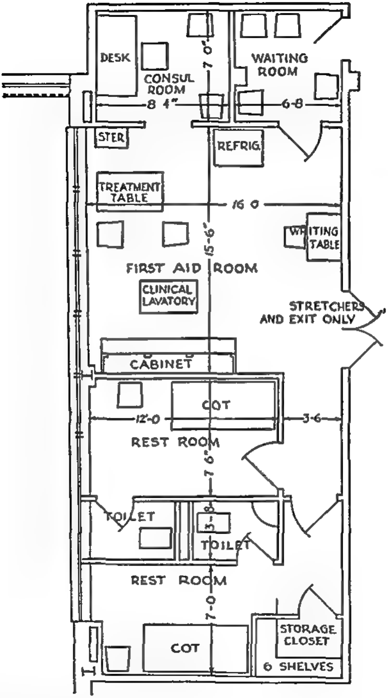

Fig 112 Essential rooms for a satisfactory first aid installation Rooms are minimal in size but adequate if volume of work is not too great

FIRST AID STATIONS

In any large industrial plant there will be one or more main dispensaries completely equipped and staffed by physicians and nurses Also there will be outlying first aid stations, in small industries these will be the only medical centers in the plant Of these facilities, the first aid stations concern us most in this discussion Each of these should consist of one room for dressings and a small consulting room which can be used for private conversations with patients or friends who have brought the workmen to the first aid station, when the physician is called to the station he can use the room either for consultations or examinations There should be two rest rooms for injured or ill employees who must lie down and await either ambulance or medical care by a physician, adjoining each of these rooms there must be a toilet The doors must be so arranged and of such size that a stretcher can be taken in and out without difficulty Two sketches are shown here illustrating different arrangements of these essential rooms Because these rooms are apt to be small, it is essential that the rest rooms have outside windows, if possible, lest injured or sick employees lying in them develop a feeling of claustrophobia In climates where the weather is hot and humid over a period of time it is almost a necessity that at least the rest rooms be air conditioned, preferably, the whole first aid station should be air conditioned Obviously these stations will be located where they are accessible to the greatest number of employees for a minimum loss of time and outdoor exposure The furniture in the room should be comfortable neat, and preferably of all metal construction there should be no unnecessary pieces of furniture A simple bed, a straight chair in each of the rest rooms a small table, a small desk, two chairs in the consulting room, one specialist type of chair with head rest which can be lowered into a reclining position (in the dressing room) a metal stool for the first aid worker, a screen, instrument cabinet, and two small dressing tables would constitute the bare minimum of furniture The instruments and supplies also should be simple, and need not be secured in large quantity because of the type of work done It is better to buy a few good instruments rather than many poor ones Stainless steel costs more but holds up better and is cheaper in the long run

X ray Facilities Frequently the question is asked just how large must a factory or industrial plant be before x ray facilities are justified in the first aid setup The answer must depend on several different factors The first relates to the medical policy of the company i e, whether or not routine chest x rays for pre-employment are required, and whether these

pictures are taken, 1,000 employees should be the dividing point It is assumed here, of course, that the first aid installation is visited daily or at least frequently by regular medical attendants

Equipment for Dressing Stations Each first aid station should have several trays in readiness for the care of a lacerated or open wound Each tray should be about 12 by 18 inches, it, as well as its contents, should be sterile and enclosed in a sterile pillow slip or towel Each time it is sterilized the date should be put on the cover and it should be resterilized at regular intervals of about one month The following items are suggested for the contents of the tray cap, mask, gown, rubber gloves, several sterile towels, catgut and some type of nonabsorbable suture material, small and large sponges, applicators, Novocain syringe and needles, scissors, knives, small straight and curved hemostats, needle holders, tissue forceps, small self retaining retractors, and any special instruments or other equipment desired by the attending physician Since it takes considerable time to set up and sterilize such trays, even the smallest first aid station should have at least two available at all times More may be required if accidents are common In addition to these trays of sterilized materials, which are kept ready for use at any time, the dressing tables in the first aid room should contain several jars adequately covered in which will be kept cotton pledgets small and large gauze squares, and applicators Beside these jars there must be a sterile forceps for taking contents out of the jars, this forceps must be kept in one of the sterilizing, noncorrosive solutions such as are now available commercially Bandage scissors pointed scissors, splinter forceps, and tissue forceps of several kinds should be kept sterilized in an instrument tray and resterilized after each use Several sizes of Band Aids or similar ready dressings should be within easy reach as well as a roller containing several rolls of adhesive tape of different widths On a lower shelf of this dressing table there should be a supply of bandages of various sizes and widths, as well as some elastic bandages of the tensor type and a few rolls of plaster bandage varying in width Also on this shelf can be kept a few board aluminum or plastic splints to be fashioned and used as necessary While it is true that every first aid station must have a few drugs on hand, these should be kept to an absolute minimum, and the list should of course be prescribed by the attending physician and given out only in accordance with his written instructions Aspirin and a few hypo tablets of morphine are probably the two absolutely indispensable drugs for a first aid station As indicated in Chapter 2, the safest cleansing agent for any wound is soap and water however, in some work the skin of the patient will be covered with so much grease that a grease

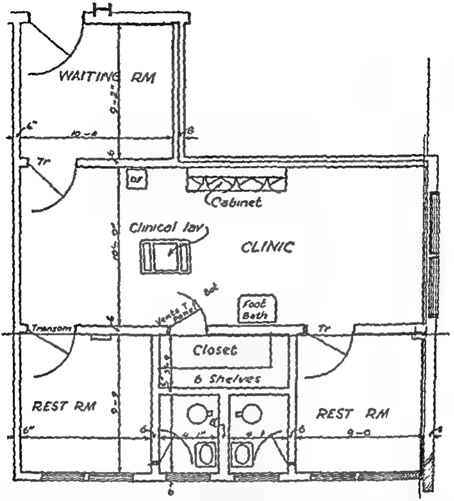

Fig 113 Alternate plan for a first aid installation In this sketch the consulting room has been sacrificed as such to permit a larger clinic for the first aid room One of the rest rooms can be used as a consulting room when necessary In both sketches nurses use one of the rest rooms as their change room and for relaxation

pictures are repeated at periodic examinations Ordinarily one x ray machine will be ample unless the main dispensary and first aid station are located far apart If the plant is small and there is no x ray in the main dispensary, then the number of employees which will justify investment in an x-ray machine will vary between 500 and 1,000 In a plant which is a little more prone to accidents and where routine chest pictures are taken, 500 employees will warrant the installation of an x ray On the other hand if it is a plant where accidents are not common and not so many chest

sume responsibility, but after rendering such temporary care as indicated, should call a physician or see that the patient is transported to the hospital A similar procedure in serious cases is obviously indicated The ability to evaluate each situation correctly and a realization of the limitations of the first aid function are the most important qualities of the industrial nurse or first aid worker

Bandaging and Protection Of the general duties of the first aid worker, proper bandaging of an open wound is necessary for several reasons, partly to keep out additional contamination but also (and this is equally important) to furnish a form of protection and rest In Chapter 4, bandaging has been thoroughly discussed and reference should be made repeatedly to the invaluable points brought out regarding the details of application of various bandages and the necessary precautions if the most value is to be obtained from bandages and they are not to restrict the parts unduly A properly applied bandage can also serve as a means of controlling hemorrhage In Chapter 7, Figure 29 shows a type of compression dressing (Gallagher) that was developed during World War II and found to be particularly useful in controlling hemorrhage, not only from major blood vessels but even from the apex of the lung when the shoulder had been injured Depending upon the severity of the injury, the part injured and the body as a whole should be put at rest The smaller the injury, the smaller the part that must be kept at rest but in any extensive wound the entire body as well as the injured part must be kept completely at rest until healing is well under way In addition to bandaging, this means adequate splinting and complete bed rest

Prior to consideration of specific injuries reference to Tables 5 and 6 will acquaint the reader with the location and nature of common industrial injuries seen in the state of Illinois during the years of 1949 to 1956 The predominance of hand and finger injuries (one third of total) is evident Perhaps the relatively low incidence of infection portrays the emphasis placed on industrial first aid

Table 5 Location of Injury

Based on 351 074 Claims Illinois 1949–1956

Head face and neck	6 4%	Trunk	18 0%
Eyes	1 6%	Leg	10 0%
Arms	7 0%	Feet	10 0%
Hands	10 0%	Toes	5 0%
Fingers	26 0%	Other injuries	6 0%

solvent such as benzene, will have to be used to cleanse the skin around the wound

Records Because of the unique position in industry of the first aid worker as well as the medical department, with responsibility both to the injured employee and to management, complete and accurate records of all injuries are essential Even a minor scratch may under certain unfavorable circumstances, result in major temporary or permanent disability A brief but accurate account of the manner in which the wound was received with a note as to its location (extremity, right or left and digit involved) appearance of the wound (fresh or several days old), and the treatment rendered should be recorded in every case Whatever system is used it should be well indexed and accessible to the first aid worker or nurse for notations each time the patient is seen

FIRST AID TREATMENT OF INDUSTRIAL INJURIES

General Principles In most industrial plants the majority of injuries occur within a few minutes distance of the first aid station or medical dispensary Depending upon the seriousness and location of the injury many employees will be able to walk to the first aid station

For those injuries of a minor nature the first aid treatment rendered will also be the definitive treatment In all cases this treatment must serve the best interest of the injured employee If the condition can be handled adequately in the first aid station and the employee safely allowed to return to work this course should be followed One of the most costly mistakes made frequently in first aid of industrial injuries is to allow men to return to work when they should be kept quiet during the first few days after their injuries to assist in preventing not only infection but partial permanent disabilities The pressure maintained constantly to eliminate all accidents is so great that physicians as well as first aid workers are often importuned to allow an injured workman to resume some sort of employment just so there will not have been a lost-time accident The prevention of accidents is of course a very laudable cause but it should never be allowed to result in poor medical management after an accident has happened At the same time it is obvious that the injured employee should not be sent home and forgotten for a week or two Existing conditions at home and the worker s intelligence may be such that some type of light work would be preferable

If there are uncertainties as to the extent or nature of the injury even though apparently minor the nurse or first aid attendant should not as-

sume responsibility, but after rendering such temporary care as indicated, should call a physician or see that the patient is transported to the hospital A similar procedure in serious cases is obviously indicated The ability to evaluate each situation correctly and a realization of the limitations of the first aid function are the most important qualities of the industrial nurse or first aid worker

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Prior to consideration of specific injuries reference to Tables 5 and 6 will acquaint the reader with the location and nature of common industrial injuries seen in the *state of Illinois during the years of 1949 to 1956* The predominance of hand and finger injuries (one third of total) is evident Perhaps the relatively low incidence of infection portrays the emphasis placed on industrial first aid

Table 5 Location of Injury

BASED ON 351 074 CLAIMS ILLINOIS 1949–1956

Head, face and neck	6 4%	Trunk	18 0%
Eyes	1 6%	Leg	10 0%
Arms	7 0%	Feet	10 0%
Hands	10 0%	Toes	5 0%
Fingers	26 0%	Other injuries	6 0%

Table 6 Nature of Work Injuries 1949–1956, Illinois

ALL INJURIES	351 074	100%
Cuts and lacerations		22 9
Fractures		21 5
Sprains and strains		15 3
Bruises and contusions		11 5
Burns		4 8
Hernia		4 1
Amputations		3 3
Inflammations		1 8
Infections		1 9
Punctures		1 3
Others		11 6

Closed Wounds Contusions to the extremities are most common, and if more than very minor, the part must be x-rayed to rule out fractures The treatment described in Chapter 5 is carried out (i e , cleansing the area, application of cold and application of a pressure dressing) as indicated The indication for this therapy depends on the degree of swelling and discoloration, cold and pressure are particularly indicated if a hematoma is present as would be suggested by a fluctuant swelling Contusions to the head, accompanied by more than very transient headache, or by even a short period of unconsciousness must be considered potentially serious and the patient is to be seen by a physician (see Chapter 16) In instances of contusion to the chest aggravation of pain on breathing coughing of blood shortness of breath, pain intensified by compressing the ribs and crackling of air under the skin upon palpation with the fingers are symptoms and signs of more serious injuries (see Chapter 14)

Frequently contusions to the abdomen do not at first produce symptoms of sufficient discomfort to suggest that underlying organs may have been injured Should there be any question as to whether the trauma has caused an internal injury a physician must be called or the patient hospitalized While making the initial survey and examination the pulse and blood pressure should be recorded and all such information forwarded to the hospital for comparison with subsequent readings and observations (see Chapter 15)

Contusions to the back and flank may produce kidney as well as musculoskeletal injury A urine specimen which is tinged with blood indicates injury to the kidney or some other organ in the genitourinary tract such as the bladder or urethra Hospitalization is mandatory for such injuries

In all contused wounds, the first aid attendant should be more concerned with the possibilities of more serious underlying injury than with the relatively unimportant treatment of the obvious surface injury When doubt exists, he must err on the side of safety for the injured employee

Open Wounds Abrasions should be cleansed and protected by a suitable dressing Such minor injuries are ideally treated by use of a single layer of fine mesh gauze directly over the area with or without a thin application of a bland ointment, an overlying gauze compress held in place by suitable outer bandage and left undisturbed until the skin has healed For abrasions to the fingers and hands, frequent dressings will be necessary because of soiling Should there appear to be any delay in healing, or if the abrasion is deep, a splint to restrict motion is indicated

Serious hemorrhage is not frequent in industrial injuries However, a sufficient number of employees must have first aid training to provide effective aid if it does occur Such measures are described in Chapter 7 The first aid attendant can bring to the scene supplementary materials such as the Gallagher dressing, a good blood pressure cuff or pneumatic tourniquet Many dispensaries have blood plasma on hand, and this should be started as an intravenous infusion if the patient shows any evidence of shock It is best to have the physician present to supervise this and the transportation of these patients however, if this is not practical, prompt removal to the closest hospital is essential after control of the bleeding

The first aid treatment of an open wound consists primarily of application of a pressure dressing to stop hemorrhage (if present) and adequate coverage or protection by a bandage (see Chapter 5 for details) For definitive care open wounds must be cleansed and irrigated, their depth and extent determined, devitalized tissue and foreign material removed underlying structures repaired, and the skin closed within an interval of time considered to be safe from the standpoint of infection if prompt clean healing and maximum function are to be obtained In the well-organized industrial medical department this is nearly always feasible The first aid attendant should recognize the *minor incised wounds,* or lacerations which will require only cleansing dressing and splint and he may become expert in the use of adhesive bridging to overcome slight degrees of gaping of wound edges In occasional instances metal skin clips are appropriate as a first aid procedure to close a small laceration Usually, however, such gaping wounds should be handled by the doctor, sutures are tolerated better than clips about the extremities Unless the plant dispensary has a well equipped operating room with adequate nurses and assistants for the surgeons the care of injuries involving more than a few

skin sutures should be given in a hospital The physician or hospital should be notified, and the patient sent ahead without delay The lapse of time from the first aid station to the hospital operating room is cumulative, and may easily exceed the four-hour 'safe period for preferred treatment if there is delay at any point Definitive treatment given after a greater interval is more frequently complicated by wound infections Because of this danger, the primary operation often must be limited to wound cleansing and debridement and the repair of underlying structures deferred until a later time Very often this loss of opportunity for primary repair in compound injuries means the acceptance of an inferior result

Examples of serious, deep wounds common in industry are as follows

1 Deep tearing *lacerations and avulsions* from forcible contact with blunt objects, either the extremity or object in motion There may be extensive skin, muscle or ligament injury, but major blood vessels, tendons, and nerves are frequently spared due to inherent toughness and mobility Large flaps of skin may be stripped up, ranging in extent from a small portion to a major injury, such as the glove type avulsions in which the skin of the hand is pulled off much in the manner that a glove is removed First aid consists of sterile pressure dressings and splint Definitive treatment calls for careful cleansing, excision of contaminated and mangled tissue, and closure by opposing the edges or immediate skin grafting In some instances the skin which has been peeled off can, after proper preparation be used as a graft

2 *Crushing injuries* are caused by a great variety of machines and other mechanisms in which the extremity or body is caught between or thrown against heavy objects In such instances compound fractures are frequent The surface lacerations are of a burst type and may not be as extensive as the disruption of underlying tissues These injuries frequently produce such damage to the walls of blood vessels that thrombosis occurs and gangrene may ensue In wringer type injuries this may occur even though no fractures are evident and the skin may be intact In all this group, voluminous, evenly applied pressure dressings as a first aid measure may help to prevent the extreme congestion with venous blood which may be more damaging than actual hemorrhage Needless to say the same type of dressing is indicated following the definitive repair Postoperative management often includes the use of anticoagulant drugs such as heparin, to further guard against the tendency to thrombosis and Novocain block of the sympathetic nerve supply to the part to improve the blood flow

3 *Traumatic amputations* particularly of the fingers though not

nearly as common since the advent of safety guards on machines, are still frequent A pressure dressing is sufficient as a first aid procedure, and prompt definitive treatment makes possible the saving of maximum length either by immediate flap closure or by primary skin grafting The latter is particularly useful in closing the stump of an amputation through the distal phalanx in order to save length and preserve the fingernail Occasionally an arm or leg may be crushed off or cut off by machinery A tourniquet and pressure dressing are both necessary first aid measures for control of hemorrhage Morphine should be given for pain, and plasma for shock, hospital treatment is urgent

4 *Emery wheel grinds* are a combination of laceration or avulsion and burn This injury is known to first aid attendants in industry for its slowness in healing and the tendency to deeper involvement than was at first evident Bleeding is minimal because the friction burn has, in effect cauterized the tissues Minor wounds of this type may be treated by cleansing, petrolatum dressing and splint If more than very superficial they may be treated by the doctor by cleansing, thorough exploration and dressing or preferably by the immediate excision of all exposed tissue to a depth of one-eighth inch, followed by primary suture Such wounds must never be sutured unless the burned tissue has been cut away The prominence of the knuckles of the back of the hand make this a common site of the injury, and frequently tendons and joints may thus be injured These involvements make doubly important the prompt removal of the patient to the hospital for early adequate treatment in order to avoid infection and permanent impairment of use of the fingers

5 Sharp edges of sheet metal or metal turnings, in addition to cutting tools are responsible for most *deep incised wounds* and *severed tendons and nerves* The skin wound is often small and bleeding minimal so that the first aid worker must exercise constant care in examining not only the immediate wound, but also the function and sensation of the extremity beyond the point of injury If there is any question of ability to flex or extend the extremity of digits distal to the laceration the tendon is probably cut Similarly if sensation is impaired nerve injury should be suspected Because of the very meager blood supply to tendons infection is very prone to develop unless the primary repair can be accomplished within four hours of the time of injury If there is delay in suspecting the tendon injury or in getting hospital care the patient must wait six to eight weeks or longer before the tendon can be repaired If infection occurs the chances for a functional result from either primary or secondary repair are very poor Although the presence of infection in nerve repair is slightly

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3 *Traumatic amputations* particularly of the fingers, though not

are variable Acid and strong alkali burns are very deceptive at first and often develop into third degree burns due to continuing action of the chemical long after exposure Patients presenting small areas of deep second or third degree involvement of the upper extremity and trunk can be treated adequately in the first aid dispensary under a physician's supervision, but if the same involvement were present on the foot or leg, this person should be hospitalized or kept in bed Small superficial burns treated by early, gentle cleansing, bland ointment, pressure dressing, splint, rest, and infrequent changes of dressing usually heal readily For extensive burns of any area equivalent to that of an upper extremity, immediate hospitalization for treatment of anticipated shock is indicated Skin grafts are indicated when third degree burns are more than an inch in diameter (see Chapter 8)

Fractures, Dislocations and Sprains The frequency of fractures varies somewhat among various industries, but generally, fractures of the fingers and toes are most common, with fractures in the hand, wrist, and foot next in frequency Ankle, heel, and leg fractures appear with slightly greater frequency than fractures in the forearm, elbow and arm Rib fractures are not uncommon Spine and pelvic fractures occurring as a result of collapse of rock or walls are frequently seen in the mining industries The first aid treatment of these varieties is covered specifically in Chapters 11 and 12 A supply of useful splints of aluminum wood, or plastic should be kept in every first aid station for the common upper extremity types Pillows are very effective as shown in Figure 62, Chapter 11 for the fractures about the ankle This pressure, evenly applied, helps minimize the swelling and is comfortable Thomas or similar splints should be available for fractures of the leg and femur The first aid worker or nurse should proceed to the scene of the accident with suitable splints for major lower extremity fractures and apply these before allowing the patient to be put on a stretcher Most patients with upper extremity fractures may be allowed to self support the injured arm in a manner which is comfortable and be brought to the first aid station for additional splinting Morphine should be given as directed by the physician for relief of pain and arrangements for hospital care effected if necessary We have previously stressed the importance of early definitive treatment of open fractures While many of the closed fractures do not require urgency, some, because of associated dislocation with injury or compression to the major blood vessels, may require immediate treatment if the limb is to be saved In minor closed fractures thorough soap and water cleansing prior to application of a splint is indicated, this serves to prevent infection of blisters

less damaging to the result there is no doubt that the earlier such injuries are cared for the better The greatest service in first aid in these cases is the prompt recognition and arrangement for adequate care Sterile dressings and splints are used as indicated

6 *Foreign bodies* are very apt to be found in wounds sustained in industry These may be slivers of wood or steel, glass, graphite, carbon cloth, and various types of metals If steel or glass, the foreign body proper is not as important as the effect it has had in damaging the underlying structures They do not often produce infection and are innocuous unless they lodge adjacent to or in a nerve, tendon muscle, or blood vessel of the extremity or penetrate an organ of the abdomen or chest X-rays should be taken for diagnosis but the decision for or against removal rests with the physician and is determined after weighing the risk of infection or future trouble against the trauma of removal Generally, superficial steel chips can be removed easily if seen early If nerves have been damaged or blood vessels injured, the immediate repair is indicated and the foreign body removed if encountered Irritation of tendons may not be diagnosed until active use is begun, and secondary removal may then be done Steel chips deeply imbedded in muscle are best left alone Wood slivers and cloth should be removed because of the danger of infection Carbon particles should be scraped out to avoid tattooing in superficial skin wounds Graphite from pencil points causes chemical destruction of tissue therefore early excision and irrigation are indicated Another foreign substance with very detrimental effect is the grease injected forcibly through a puncture by the tip of a grease gun Here immediate evacuation by the physician of as much of the material as possible by numerous incisions is indicated followed by treatment of any subsequent infection or necrosis The depth of penetration and the experience of the attendant are the criteria for deciding whether foreign bodies can be handled in the first aid station

Burns Burns of all types are encountered among industrial accidents and range from the minor superficial to complete cremation Obviously the latter are not seen in the first aid dispensaries Of the minor varieties first aid treatment similar to that mentioned under abrasions can be applied Cleanliness and protection by rest are the principles here involved As the seriousness increases first aid treatment as described in Chapter 8, should be applied It should be remembered that the depth of involvement is frequently difficult to assess correctly from appearance alone Hot metal burns are usually third degree Burns from ignition of clothing saturated with gasoline are deep second and third degree Hot water burns

casionally, in spite of the use of safety glasses (much more common when glasses are not used) flying chips of steel lacerate or penetrate the cornea or sclera Such wounds must receive expert care from an eye specialist as soon as possible if the vision is to be saved First aid consists in covering the eye with a sterile gauze patch The treatment of burns of the eye is described in Chapter 8

Miscellaneous Types of Emergencies Electric shock and asphyxiation by gases are serious emergencies, and must be treated quickly by artificial respiration and other measures as outlined in Chapters 6 and 13 if respirators are not available Portable resuscitators are useful when of accepted type and their operation is understood A small emergency oxygen tank for use with a mask is extremely valuable in conjunction with artificial respiration or after such patients resume respiratory activity Other medical emergencies such as acute coronary occlusion (see Chapter 21) can be materially benefited by oxygen as a first aid measure Heat exhaustion and heat cramps (see Chapter 21) should be well understood by the first aid worker in industry, and protection of the workers by salt administration carried out systematically

Finally, the first aid worker in industry serves an important function when he can apply such treatments as he may be called upon to perform with efficiency, good judgment understanding and a desire to help in every situation to the best of his ability

which tend to appear with subsequent swelling Pressure dressings and elevation of the part help to minimize the swelling

Sprains of the wrist and ankle are most frequently encountered and can be diagnosed only after adequate examination by the physician X rays are essential Treatment may be given on a presumptive basis in mild conditions but subsequent examination by the physician is necessary (see Chapter 11) Sprains of the back are of importance because of their frequency and ensuing disability The first aid worker may easily underestimate the seriousness of this condition and should be cautious in allowing patients to return to work without first seeing the doctor Rest, in a reclining position and heat are helpful Many mild sprains are aggravated by ill advised attempts to return to stooping and lifting

Hernia Reference again to Table 4 in this chapter reveals an incidence of 4 1 per cent of hernia It is important that the first aid worker obtain an accurate history of possible injury and symptoms The common accidents reported by the worker are unusual lifting straining or slipping which forces the injured into a stretched or awkward position The first aid attendant should note and record such complaints as groin pain, low back pain, periumbilical pain, scrotal or testicular pain, nausea and of course the sudden appearance of inguinal swelling Often the swelling does not occur immediately It is in these cases that the initial notation of presenting symptoms is of greatest importance In most states the hernia is said to be compensable when initiated or preceded by the above findings

The pain incidental to a newly protruded hernia can be relieved by placing the patient in a reclining position which will result usually in spontaneous return of the contents into the abandoned cavity When this fails to produce relief or the hernia cannot be reduced incarceration or strangulation should be suspected and a physician called immediately

Eye Injuries Foreign bodies in the eye are of daily occurrence in industrial first aid stations The first aid attendant will find that a good light and magnifying lenses are necessary in the treatment of these patients By shifting the light beam to strike the corneal surface from different directions very few foreign bodies or abrasions of the corneal surface will be missed The method of inspecting for foreign bodies is depicted in Chapter 5 Figure 26 The eye is then irrigated with sterile physiologic saline solution which will frequently flush out the particle Moistened cotton tipped applicators are used gently to wipe out the particle If as is frequent in industry the particle is imbedded in the cornea or sclera a physician should be called The reddening of the sclera should be recognized as evidence of eye infection and proper medical referral advised Oc-

6,350 drownings (The fact that 2,800 deaths were listed under more than one category accounts for the apparent discrepancy of these figures) These were only the fatal accidents A total of nearly 9,000,000 disabling injuries occurred in 1958 of which 340,000 resulted in some permanent disability Thus, every day more than 25,000 persons are injured and 250 die of their injuries One out of every 19 persons is disabled by injury during the year These enormous figures emphasize the need for a large number of personnel trained properly to administer immediate treatment to the injured The physician can do this best and the hospital offers the most ideal facilities, but unfortunately neither is always readily available It is certain that if proper first aid care were available at the time of the accident many fatal results could be averted

Because of the high speed of driving, most automobile accidents produce serious injuries Of the 1,350,000 persons injured in automobile accidents during 1958, 95 per cent required the care of physicians Multiple fractures, often open, were frequent Crushing injuries with damage to organs within the thoracic or abdominal cavity were not uncommon Fractures of the skull or spine with or without damage to the central nervous system occurred often and frequently were fatal All these injuries are very serious and demand proper emergency care Many victims died because well intending but poorly informed passers-by handled them roughly, "threw' them into cars, and rushed them off at high speed to seek aid

Nearly half of all accidental disabling injuries occur in the home—4 000,000 in 1958 This is one in every seventh home Of this number, 27,000 resulted in death Falls produced almost 50 per cent and burns were next most frequent accounting for 5,800 deaths Most home accidents are the result of carelessness Hundreds of children die of burns or scalds because parents leave matches fire, or boiling pots within reach Misplaced furniture, slippery floors, toys or marbles on the rugs, loose steps or boards are common causes of serious falls We should be as urgent in our education to prevent such accidents as we are in giving first aid training to meet them

Despite efforts by both government and industry to guard against industrial hazards, about 1 800,000 persons were injured at work in 1958 and almost 1 per cent of such injuries proved fatal The highest frequency rates occur in those industries which are by their nature dangerous, such as marine transportation lumber mining and construction The manufacture of explosives carries a low accident frequency rate but it is likely to be increased during wartime because of sabotage Falls constitute one

Statistics obtained mainly from the National Safety Council

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Civilian Versus Military Casualties

CHARLES B. PUESTOW

Modern warfare, as demonstrated in recent wars, revealed the dangers of personal injury to civilians as well as to military personnel and inspired many to seek training in first aid. However, statistics show a high incidence of civilian accidents even in peacetime and the great need for those properly trained in first aid in all walks of life at all times. None of the modern wars were fought within the United States and our civilian population escaped injuries resulting from battle activities. Our national statistics do not indicate that wartime, compared with peacetime, affected our national accidental death rate. There has been a fluctuating but gradual decrease in the national accidental death rate since the turn of the century. In 1922 the rate was 69.4 deaths per 100,000 population, a total of 74,000 fatalities. In 1958, thirty-six years later, the rate was 52.5 deaths per 100,000 population, a total of 91,000 individual deaths. The decrease in the death rate is undoubtedly the result of education in the prevention of injuries and in the care of the injured.

Our national accidental death rate remains deplorable, one of the highest in the world. Civilian accidents rank fourth in the causes of all deaths, being exceeded only by heart disease, cancer, and cerebral hemorrhage. Accidental deaths rank first among the 1 to 26 year age group. The accident toll increased 2 per cent from 1939 to 1949. More people were killed accidentally in the United States in 1941 than were wounded fatally during the entire World War I in the American Expeditionary Forces. This deplorable record was repeated during World War II when in the period from Pearl Harbor to V-J Day, accidents in the United States caused 79,622 *more* civilian deaths than our total military casualties, and 36,000,000 civilian injuries compared with 670,584 wounded military personnel.

In 1958 there were over 91,000 accidental deaths: 37,000 from automobile accidents, 27,000 from injuries sustained at home, 13,300 from occupational mishaps, and 16,500 public fatalities which included about

such as severe hemorrhage, home remedies can be avoided They are usually unnecessary and often complicate proper subsequent medical care

With the recognition by most industries of the value of early and appropriate medical care of injuries, such service has been made available and its use mandatory Because of this, most industrial accidents develop fewer complications and serious sequelae than those of any other group

Peacetime accidents in general should be better handled than those encountered in wartime They occur singly or in small groups Medical and hospital facilities usually are accessible Delay of hours or days because of great numbers of injured or lack of facilities seldom is necessary Adequate time may be taken to give the injury the best possible treatment Necessary facilities are at hand to do this Aseptic technic usually can be employed Treatment may be individualized and not confined to a standard form as sometimes is necessary during warfare However civilian injuries are not always handled in a satisfactory way Delay in getting medical care is one reason Ill advised first aid often does harm Medical management sometimes is careless and inadequate Greater interests by both laymen and physicians should markedly reduce the appalling accident toll

WARTIME CIVILIAN ACCIDENTS

The character of warfare as conducted in World War II and the Korean War wrought havoc among civilians—men, women, and children alike The nature of any future military conflicts will no doubt substantially increase the havoc Aerial bombing and the types of bombs used, including atomic energy are the chief causes The severe injuries produced by atomic bombs and by other bomb fragments constitute but a small percentage of civilian injuries Other factors are blackout accidents collapsing buildings flying or falling debris fire and blast With the introduction of blackouts as protection against enemy air raids, civilian casualties greatly multiply Automobile accidents and falls are common and often serious The absence of light may cause considerable delay in finding victims and administering medical care The difficulties of working in darkened rooms with inadequate facilities do not enhance the quality of care given In spite of such handicaps, reports on recent wars indicate remarkably good results and a splendid morale Gradual adjustment of the public to blackout conditions and the introduction of many safety factors help to cut down the incidence of such injuries

Crushing injuries due to collapse of buildings and the destruction of

of the commonest causes for industrial accidents as they do for home injuries Many industries have taken every known precaution to prevent accidents However, they also have provided both equipment and trained personnel to administer first aid Physicians or nurses are constantly available and can be attending the patient in a very few minutes Often many of the employees are instructed in first aid, especially that referable to the hazards of their particular occupation The value of proper first aid and skilled medical care has been proven by the low incidence of wound complications such as infection, the shorter average period of disability and the diminished permanent disability in industries having a good medical department

Peacetime civilian injuries differ as to cause, nature, and treatment from wartime civilian or military accidents Most peacetime accidents occur singly or involve only small groups of people Assistance usually is available in a very short time and if properly administered, the victim rarely need suffer from long exposure, continued blood loss, or delayed medical attention Serious automobile injuries have increased greatly in rural areas because of high speeds However, such an accident rarely occurs without being noted by someone in a very few minutes Transportation usually is available and few locations are more than an hour s ride from a physician or hospital If most observers could be taught to realize that after carefully examining an injured person, laying him flat and covering him they should use their efforts to bring an ambulance to the patient and not try to transport him many lives could be saved Most serious automobile accidents include fractures These should be looked for and splinted Internal injuries also are frequent With the general use of safety glass and safety belts fewer extensive lacerations with serious bleeding are encountered Most accidents result from violent impacts which produce crushing injuries

Home injuries likewise usually occur singly and most often result from falls These patients should be made comfortable in a horizontal position until medical aid arrives Burns are the second most frequent of home injuries and often are serious or fatal The most important duty of the victim or someone else present is to extinguish the fire In the panic of fire this often is not done immediately Victims of home injuries rarely are exposed to unfavorable extraneous conditions Medical aid is convenient and can be secured in a short time Thus first aid can be limited to efforts to keep the patient comfortable and to allay his fears The time interval between injury and the execution of proper medical treatment rarely is of sufficient length to endanger the patient and except in urgent emergencies

mediate mortality was high However, due to advances in treatment, the recognition of factors involved, and organization to administer excellent care quickly, the immediate mortality was lowered and late complications greatly reduced Extensive suppuration in wounds and the development of tetanus and gas gangrene have taken a heavy toll in previous wars Many amputations were performed on extremities which could have been saved if infection had not developed Modern treatment as practiced in World War II and the Korean War reduced the mortality rate from infections and the incidence of amputations to a figure probably no greater than one fourth that in World War I

COMPARISON OF CIVILIAN AND MILITARY WOUNDS

Soft Tissue Wounds The ideal treatment of soft tissue wounds as practiced in *civilian emergencies* is an immediate thorough cleansing debridement and primary closure, if sufficient viable tissue remains to permit this to be done without undue tension If this is performed properly within six hours of the time of injury primary union without suppuration is the general rule The cleansing must be gentle but thorough and is done usually under aseptic conditions using a mild soap, sterile water or physiologic saline solution and cotton The operator should be scrubbed clothed in sterile cap gown and gloves, and masked to prevent the introduction of microorganisms from the nose or mouth The area surrounding the wound is cleaned first, precautions being used against contamination of the wound itself Sterile drapes then are arranged and the wound is cleaned After a change of gown, gloves and drapes the wound is debrided, all foreign bodies and all devitalized tissue being removed Primary suturing then can be done Most injured civilians can reach a hospital sufficiently early for such care and adequate facilities are at hand

Military wounds however rarely can receive the treatment described in the preceding paragraph Facilities are not at hand for this immediate care and when many casualties occur at one time the physicians must treat the more critically wounded first generally those with abdominal thoracic or head injuries This may delay the treatment of less urgent wounds many hours or even days When care is finally rendered sterile facilities and the necessary equipment may not be available With the large first aid and medical personnel necessary to a military unit some standardization of treatment must be adopted to secure uniformly good results and to allow stocking of necessary supplies An ample supply of

bomb shelters are a serious civilian menace Fatal or serious injuries are common Many victims are partially buried and extricated with difficulty and delay The large number of casualties and the destruction of hospitals and dressing stations greatly tax the facilities for treatment Shock from exposure and blood loss is frequent Contamination of wounds is common Frightfully extensive and disfiguring wounds result from flying debris, especially broken glass Limbs may be severed faces mutilated, chests and abdomens laid open or penetrated and the underlying viscera badly injured Many such victims cannot recover A type of injury seldom seen in peacetime is that due to blast and the ravages of atomic explosions have never been encountered except in wartime

TYPES OF MILITARY INJURIES

The character of injuries sustained by combatants has changed with the development of modern warfare In the Franco Prussian War 90 per cent of wounds were inflicted by bullets These are produced by high velocity missiles which penetrate and perforate but do not cause extensive damage for great distances beyond their pathway Their immediate danger lies in the penetration of vital structures their delayed effects are chiefly due to infection In World War II and the Korean War bullets produced but a small percentage of military injuries Bombs and long range shells explode to give off fragments traveling at low velocity which damage and devitalize tissue for a considerable distance beyond their actual contact Bones frequently are shattered These bomb and shell fragments also carry with them much clothing dirt and bacteria Such wounds need extensive early surgical care Burns are very frequent and may involve large areas of the body They may result from explosions of bombs or from the firing and explosion of ammunition dumps oil and gasoline stores and the igniting of other inflammables Flame throwers are another form of weapon which increases burn casualties Shock has been an important factor in all wars but has become increasingly prevalent as war machines have become more damaging A bullet wound can produce shock by blood loss by prolonged exposure or by the extensive shattering of bone but the incidence is less frequent than that accompanying bomb or shell injuries These latter usually produce more extensive tissue damage as well as a disturbance of the nervous system Burns likewise produce severe shock Blast produces a very serious form of shock

In general military injuries in World War II and the Korean War were more extensive and more devastating than in previous wars The im

Shock In *civil accidents* shock often is due to hemorrhage, either external or into body cavities or tissues For this as well as most other forms of shock (except that produced by burns) whole blood is most satisfactory As blood banks are accessible and suitable donors can readily be obtained, blood transfusions are routinely employed in shock This is less feasible in *military life* Whole blood is difficult to transport and can be kept in satisfactory condition only for a few days Blood plasma, on the other hand, can be kept indefinitely It is easily transported and is packed in containers complete with all equipment necessary for administration Plasma transfusions can be given in a few minutes under most adverse conditions However, whole blood is being used more and more in military life, because it is much superior to plasma in shock due to hemorrhage

Blast shock was *a condition frequently encountered in World War II* and the Korean War but seldom is seen in civil life The sudden concussion of an explosion produces multiple minute or more extensive hemorrhages throughout the viscera, especially the lungs The nervous system also is affected Very little superficial evidence of injury may exist However, if a comparatively minor surgical procedure is performed on a blast victim a fatal outcome may follow The details of blast shock may be found in Chapter 10

Open Fractures One of the important lessons learned in World War I was the beneficial effects of the immobilization of fractured extremities The dictum to splint them where they lie has been taught universally for both military and civilian fracture victims It is stressed in medical schools and in first aid classes It has saved many lives The aims of fracture treatment are essentially thorough debridement of soft tissues, removal of all foreign particles and all devitalized tissue apposition of fractured bone ends, and immobilization of the extremity All of these are essential for good results Variations in the treatment of open fractures are designed primarily for different methods of handling the soft tissue injury

When *open fractures* in *civilian accidents* can be treated immediately or during the first few hours after injury, many surgeons advocate reduction debridement and primary suture of the soft parts followed by the application of firm fixation in the form of casts or adequate traction *Open fractures* occurring in the *combat zone* usually receive primary treatment in field or evacuation hospitals In these installations, definitive care can be given but because of rapid evacuation, the patients cannot be maintained in traction Therefore the wound is thoroughly debrided and covered with strips of petrolatum gauze, the fracture is reduced if possible,

sterile dressings must be available to protect wounds Most combatants carry a first aid packet which contains a large dressing suitable to tie around most types of wounds to protect them from further contamination Chemotherapeutic agents and antibiotics usually are not available to the first aid man but are on hand at dressing stations for early administration to the wounded They are particularly important if good medical care must be delayed The essential features of surgical care consist of a thorough debridement, great care being taken to remove all foreign matter and devitalized tissue, especially muscle Generally these wounds are then treated as open wounds with emphasis placed upon immobilization of the injured part

Burns Many different treatments for burns are advocated by physicians in *civilian life* All, however are aimed at combating shock, preventing infection, and avoiding deformity and dysfunction Thorough cleansing and debriding are essential Prevention of contamination is paramount Relief of pain is important Pressure dressings to prevent swelling and fluid loss are advocated Civilian burns usually can receive treatment early The involved areas are cleaned with sterile precautions Burns of the hands, face, and genitalia most frequently have some form of ointment applied, although their use is controversial Pressure dressings and splints are used on the hands Body burns may be covered with petrolatum gauze and should be protected by dressings for relief of pain and avoidance of further contamination When third degree burns are encountered immediate or delayed split skin grafts can be applied

In *military life* where many burn casualties may occur simultaneously some of these treatments may not be feasible Even sterile water may not be accessible For this reason a standard treatment as outlined in Chapter 8 on burns has been suggested

In the field shock is combated by the administration of plasma and morphine given for the relief of pain When burns are severe, tetanus antitoxin, or toxoid if the patient has been immunized should be administered Sterile petrolatum should be applied to the burned surfaces and covered with sterile fine-mesh gauze A pressure dressing should be applied over this When casualties reach the hospital, the burned areas should be cleaned with neutral soap water and cotton Loose shreds of skin should be removed and large blisters punctured Dressings of sterile petrolatum and fine mesh gauze covered by pressure dressings are applied and should not be changed for at least ten days unless complications develop To prevent contractures and deformities, skin grafting should be performed as early as practicable

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and a cast is applied Such patients can then be transferred to the zone of interior for subsequent care Where reduction cannot be obtained or maintained in the forward hospital the wound is debrided and covered with strips of petrolatum gauze and a cast is applied to maintain stability and immobilization with the bones in as satisfactory position as is possible These patients then are evacuated to the zone of interior where, at a later date, adequate reduction and fixation can be instituted in the most satisfactory manner Antibiotic therapy usually is maintained at least until the casualties reach the zone of interior In contradistinction to civilian compound fractures, primary closure is seldom attempted because of the delay period between the time of the injury and the administration of treatment and because of the extensive contamination of the wounds